CONTENTS

FIGURES

TABLES

1. MAPS

This section of the Detailed Site Report (DSR) identifies the location of the Roswell Global Nuclear Energy Partnership (GNEP) site using state, county, and local scale maps. A number of figures and maps are provided to adequately represent the information required for this and other sections of the DSR. The information is presented in diagrammatic figures and on 11 × 17-inch maps that present higher density information at larger scales. The diagrammatic figures and 11 × 17-inch maps are included following the first reference or are grouped and located at the end of the section to facilitate presentation. Maps larger than 11 × 17 inches are provided as separate pdf files to support the required electronic submittal format.

Roswell site location maps, which are shown at the state (1-019), county (1-010), and local scale level (1-001, 1-018, 1-021) contain sufficient content and detail to support preparation of an Environmental Impact Statement (EIS). The maps required in this section are designed to document the spatial relationships between the Roswell site and 1) surrounding communities, 2) utilities and transportation, 3) land use and water bodies, and 4) facility requirements. Table 1-1 identifies the broad range of information found on the figures presented. The following sections describe the figures, the information presented in them, and, in many cases, identify required information that is not present within the area represented.

Table 1-1. Map content requirements.

Location	Land Use and Water Bodies	Utilities and Transportation	Facility Requirements
State	Historic sites	Highways	Current zoning
County	Archaeological sites	Railways	Site dimensions
Municipality	Native American Lands	Roads	Construction zone
Township, range, section	Federal, state, local parks and natural areas	Transmission corridors	Buildings or structures
Place names	Non-attainment areas	Utility right-of-way	Exclusion zone
Residential areas	Trust lands		
Schools	Military reservations		
Airports	Flood plains		
Industrial areas	Water bodies		
Commercial areas	Wetlands		
Universal Transverse Mercator (UTM) coordinates	Rivers		

1.1 Overview and Summary

The Roswell site is located in the arid high desert ranchland of east-central New Mexico's Chaves County (1-010), 40 miles east of Roswell (Figures 1-1 and 1-2). The Roswell site is wholly located in Chaves County 3 miles west of the Chaves/Lea County line, in Township 11 South, Range 31 East, Sections 17 and 18 New Mexico Prime Meridian Public Land Survey System (1-033). The centroid (1-025) of the site is at 33.368 degrees north latitude and 103.851 degrees west longitude.

- The Roswell site is surrounded by largely undeveloped private rangeland to the north, east, and south and by land managed by the Bureau of Land Management (BLM) to the west.
- Currently, there are no existing structures or facilities within the boundaries of the site. The only facility within a 6-mile radius is a surface waste management facility permitted by the New Mexico Oil Conservation Division and owned by Gandy Marley, Inc.
- One historical site (the Backus Windmill) (1-011) is located within the 6-mile buffer area (1-002).
- The only "water bodies" (1-036) present are depressions that collect ephemeral runoff from local precipitation or snowmelt. Water is available from wells in the Ogallala aquifer less than 2 miles to the east.
- Within the Roswell site, the western 480 acres is zoned industrial for use as a Resource Conservation and Recovery Act (RCRA) hazardous waste disposal facility and the remaining 440 acres are zoned for agricultural use.
- The Roswell site is located 3 miles south of U.S. Highway 380 (1-032), which leads to U.S. Highway 290 approximately 35 miles to the west. State Road 172 is 3-miles east of the Roswell site (1-026).
- Rail system access may be obtained along a trunk line running from Roswell northeast to Elida and Portales (1-022). The shortest linear distance to the rail line is 30-miles northwest of the Roswell site.
- Approximately 3.5 miles of improved road (1-006, 1-009) would be needed to provide access for facility construction and operations.
- Within the 50-mile radius of the Roswell site there are three major civil divisions: Roswell, Artesia, and Lovington (1-031).

1.2 Site Location

The Roswell site consists of two contiguous land tracts that total 920 acres. The site property includes all of Section 17, except the southeastern quarter-quarter section, and the eastern half of Section 18. These two tracts (A and B) are described as follows:

- Tract A is located in Section 17: NE ¼; E ½ SW ¼; E ½ NW ¼; W ½ SE ¼; and NE ¼ SE ¼.
- Tract B is located in Section 17: W ½ SW ¼; W ½ SW ¼ and in Section 18: E ½.

The Roswell site is surrounded by largely undeveloped private rangeland to the north, east, and south and by land managed by the BLM to the west. Figure 1-3 shows township, range, and section boundaries, as well as UTM coordinates in the vicinity of the Roswell site.

1.3 Site Boundary and Dimensions

The specific requirements for presenting the Roswell site boundary and dimensions are presented in Table 1-2. All the required information is available; however, there are no structures or facilities within the Roswell site so none are depicted in the referenced figures.

Table 1-2. Required Roswell site boundary and dimension information.

Requirement	Figure
Roswell site on state map	Figure 1-1
Roswell site on county map	Figure 1-1
Roswell site showing township, range, section	Figure 1-3
Roswell site boundary, perimeter dimensions	Figure 1-4
Roswell site area	Figure 1-4
Exclusion area	Figure 1-4
Structures and facilities	None Present
Major Land Use (U.S. Geological Survey [USGS] Land Use/Land Cover classifications)	Figure 1-4

Figure 1-4 shows the boundary and linear perimeter dimensions of the 920-acre Roswell site. In the absence of a programmatic conceptual facility design, it is not possible to identify the exclusion zone, although we have indicated a typical exclusion zone of 1-mile radius. Currently, there are no existing structures or facilities within the boundaries of the site. The only facility within a 6-mile radius is a surface waste management facility permitted by the New Mexico Oil Conservation Division and owned by Gandy Marley, Inc., which is further discussed in Section 15, Other Facilities. Figure 1-4 identifies land use following the USGS land use classification system (1-005) and shows the Roswell site (1-021) boundary dimensions. Figure 1-5 identifies property owned by Robert W. Marley in the vicinity of the Roswell site.

1.4 Zoning, Structures, and Transportation

The specific requirements for showing zoning, structures, and transportation are identified in Table 1-3. The underlying zoning for the site is agricultural. The western 480-acre portion of the site is zoned industrial for use as a hazardous waste disposal facility. Section 12, Regulatory and Permitting, includes additional discussion of the zoning in the vicinity of the site. In the absence of a facility conceptual design, a detailed construction zone with location of planned buildings and structures cannot be shown and therefore none are depicted on the maps.

Table 1-3. Required buildings and structures information.

Requirement	Figure
Roswell site construction zone	No Design
Roswell site current zoning classification	Figure 1-6
Planned buildings and structures	No Design
Transportation routes	Figure 1-6

U.S. Highway 380 is within 3 miles of the Roswell site and leads to U.S. Highway 285 approximately 40 miles to the west (1-032). Rail system access may be obtained along a trunk line running from Roswell northeast to Elida and Portales (1-022). The shortest linear distance to the rail line is 30 miles northwest of the Roswell site. Approximately 3.5 miles of improved road would need to be installed to provide access for facility construction and operations (1-006, 1-009). Figure 1-6 identifies current zoning, local highways, improved roads, and unimproved dirt roads at the local scale.

1.5 Site Characteristics within 10 Kilometers

The specific requirements for characteristics within a 10-kilometer (6-mile) buffer zone around the Roswell site are presented in Table 1-4. Location data are available for all 22 required categories; however, 10 of the 22 do not occur within 6 miles. The Roswell site is located in the remote arid high desert ranchland of eastern New Mexico and is used only for grazing. The only facility within a 6-mile radius is a surface waste management facility permitted by the New Mexico Oil Conservation Division owned by Gandy Marley, Inc., which is discussed further in Section 15, Other Facilities. U.S. Highway 380 passes 3 miles north of the Roswell site (1-032) and State Road 172 is 3 miles east (1-026). One historical site (the Backus Windmill) (1-011) is located within 6 miles, and the only “water bodies” present (1-036) are depressions that collect ephemeral runoff from local precipitation or snowmelt (additional discussion and details are found in Section 2, Aquatic, Ecological and Riparian Communities; Section 4, Critical and Important Terrestrial Habitats; Section 10, Weather/Climatology; and Section 11, Hydrology/Flooding). Water for the Roswell site is provided from wells in the Ogallala aquifer less than 2 miles to the east. Requirements for reporting archaeological sites do not allow public dissemination of archaeological site locations so this information is not presented, although archaeological sites are discussed in Section 7, Historical, Archaeological, and Cultural Resources. The information identified in Table 1-4, with the exception of current zoning classification, is shown in Figure 1-7. Current zoning classification is shown in Figure 1-6 (1-015).

Table 1-4. Required characteristics for the Roswell site located within the 10-kilometer (6-mile) buffer.

Requirement	Figure
Roswell site boundary with a 10-kilometer (6-mile) radius	Figure 1-7
County and local boundaries	Figure 1-7
Railroads	None Present
Place names	Figure 1-7
Residential areas	Figure 1-7
Schools	None Present
Airports	None Present
Industrial and commercial areas	Figure 1-7
Roads	Figure 1-7
Facilities	Figure 1-7
Prisons	None Present
Major Land Uses (USGS Classification)	Figure 1-7
Current zoning classification	Figure 1-6
Utility rights-of-way	Figure 1-7
Rivers and flood plains	None Present

Table 1-4. (continued).

Requirement	Figure
Water bodies and wetlands	None Present
Trust lands	None Present
Historic sites	Figure 1-7
Archaeological sites	Cannot Show[a]
Native American Lands	None Present
Military reservations	None Present
Federal, state, local parks and natural areas	None Present

a. Location of archaeological sites cannot be publicly disclosed in accordance with Section 304 of the National Historic Preservation Act (NHPA) of 1966, as amended, and Section 9 of the Archaeological Resources Protection Act (ARPA) of 1979, as amended. Archaeological sites are further discussed in Section 7.

1.6 Site Characteristics within 80 Kilometers

The specific requirements for identifying site characteristics within 80 kilometers (50 miles) (1-003) of the Roswell site are presented in Table 1-5. Location data are available for all 10 required categories; however, two of the 10 do not occur within the 80-kilometer (50-mile) radius. There are no Native American Lands or Clean Air Act (CAA) non-attainment or maintenance areas within the 80-kilometer radius (50 miles). There are only three major civil divisions within 80 kilometers (50 miles) (1-031), Roswell (40 miles west of the Roswell site), Artesia (45 miles to the southwest), and Lovington (40 miles to the southeast). Smaller towns of Elida, Tatum, and Hagerman lie 45 miles north, 30 miles southeast, and 30 miles southwest of the Roswell site, respectively. Section 6, Regional Demography, provides additional detail on the demographics of the area. U.S. Highway 285 (1-032) is the major north-south route serving the area and U.S. Highway 380 is the major east-west transportation route. The nearest rail system (1-022) runs north through Artesia to Roswell and follows U.S. Highway 70 northeast through Elida. This rail line comes within 30 miles of the Roswell site. The major water body (1-036) is the Pecos River (1-046), located 35 miles west of the Roswell site. Also located on the Pecos River near Roswell are the Bitter Lake National Wildlife Refuge (NWR) and Bottomless Lakes State Park (1-039). Flood plains are limited in extent and are associated with the Pecos River and its major tributaries. The information presented in Table 1-5 is shown in Figure 1-8.

Table 1-5. Required characteristics of the Roswell site located within the 80-kilometer (50-mile) buffer.

Requirement	Figure
80-kilometer (50-mile) radius from Roswell site location	Figure 1-8
Major civil divisions	Figure 1-8
Highways	Figure 1-8
Rivers and flood plains	Figure 1-8
Water bodies	Figure 1-8
Transmission corridors (utility lines)	Figure 1-8
Native American Lands	None Present
Military reservations	Figure 1-8
Federal, state, local parks and natural areas	Figure 1-8
CAA non-attainment and maintenance areas	None Present

1.7 Future Site Improvements

Future site improvements will be necessary to support construction and operation of GNEP facilities at the Roswell site. The site is located near U.S. Highway 380 and a greater than 13.5-kilovolt (kv) power line (Figure 1-8). Access to the rail system is further to the west. A brief summary of road, railroad, and utility improvements is presented below.

1.7.1 Road Access

Construction of new roads or upgrading of existing asphalt and dirt roads would be required to access the Roswell site from U.S. Highway 380. Routing of these roads would be 2 miles southwest from the U.S. Highway 380 exit using existing roads to the surface waste management facility (see Section 15, Other Facilities) and an additional 2 miles southwest to the center of the Roswell site. Road access would require acquisition of rights-of-way as well as meeting the requirements of the *Interim Specifications as Replacement to the 2000 Edition of the Standard Specifications for Highway and Bridge Construction* (1-047).

1.7.2 Railroad Spur Access

An existing section of railroad track owned and operated by Burlington Northern and Santa Fe and/or Union Pacific Rail Roads runs through Roswell and northwest through Elida. Supporting rail access would require approximately 30 miles of new track construction over private, federal, and state lands. Sufficient rights-of-way clearances would need to be established. All track design and construction will be governed by 49 CFR 4, *Transportation Chapter II Federal Railroad Administration, Department of Transportation* (1-048).

1.7.3 Utilities

One electrical power distribution line (>13.5 kv) is located several miles to the east. Construction and maintenance of a new line and substation will require acquisition of rights-of-way clearances.

1.7.4 Water Supply

One existing water well, owned by Robert W. Marley (a principle in Gandy Marley, Inc.), is present within 3 miles of the site the property and two additional wells are permitted for construction. Distribution piping from these wells can be installed on property owned by Mr. Marley. Additional new water wells may be constructed and will be installed under the requirements of the New Mexico Office of the State Engineer. See Section 3 for further discussion of the requirements for obtaining additional water rights.

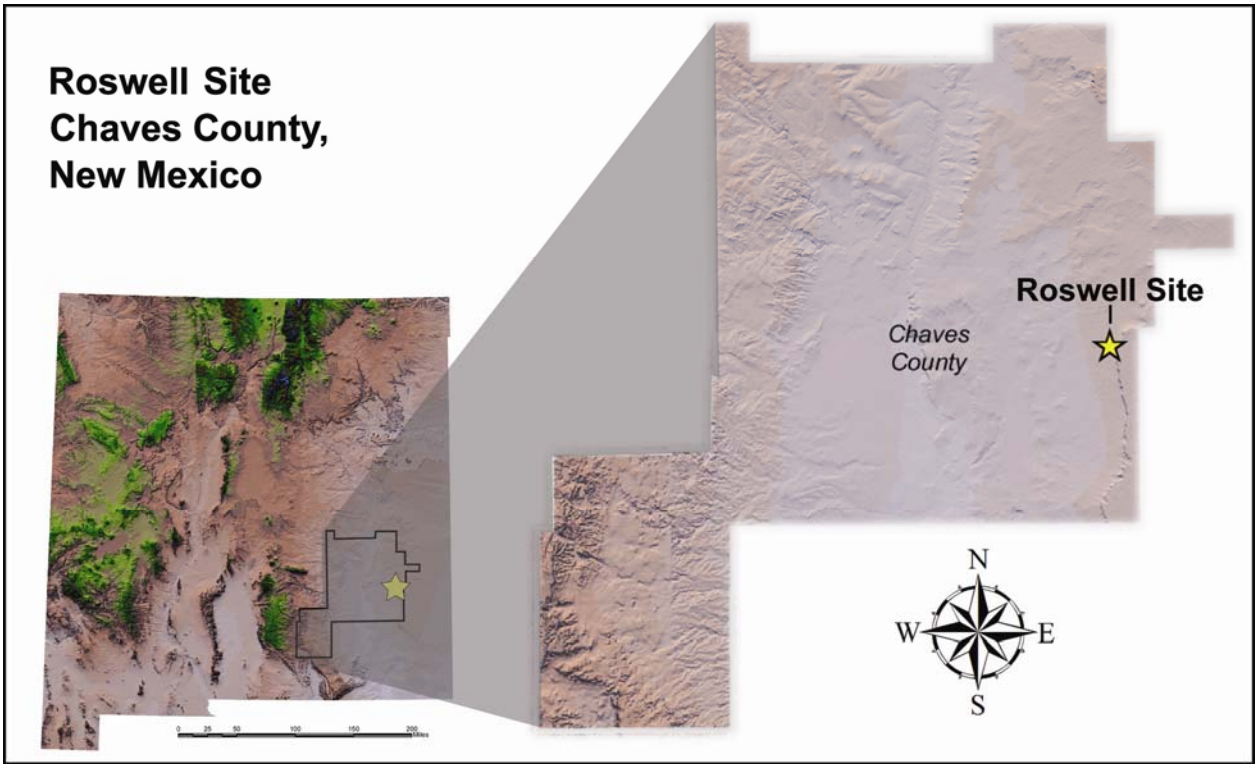

Figure 1-1. Location of the Roswell site, Chaves County, New Mexico (1-010, 1-019).

Figure 1-2. View of the Roswell site looking northwest from Mescalero Point.

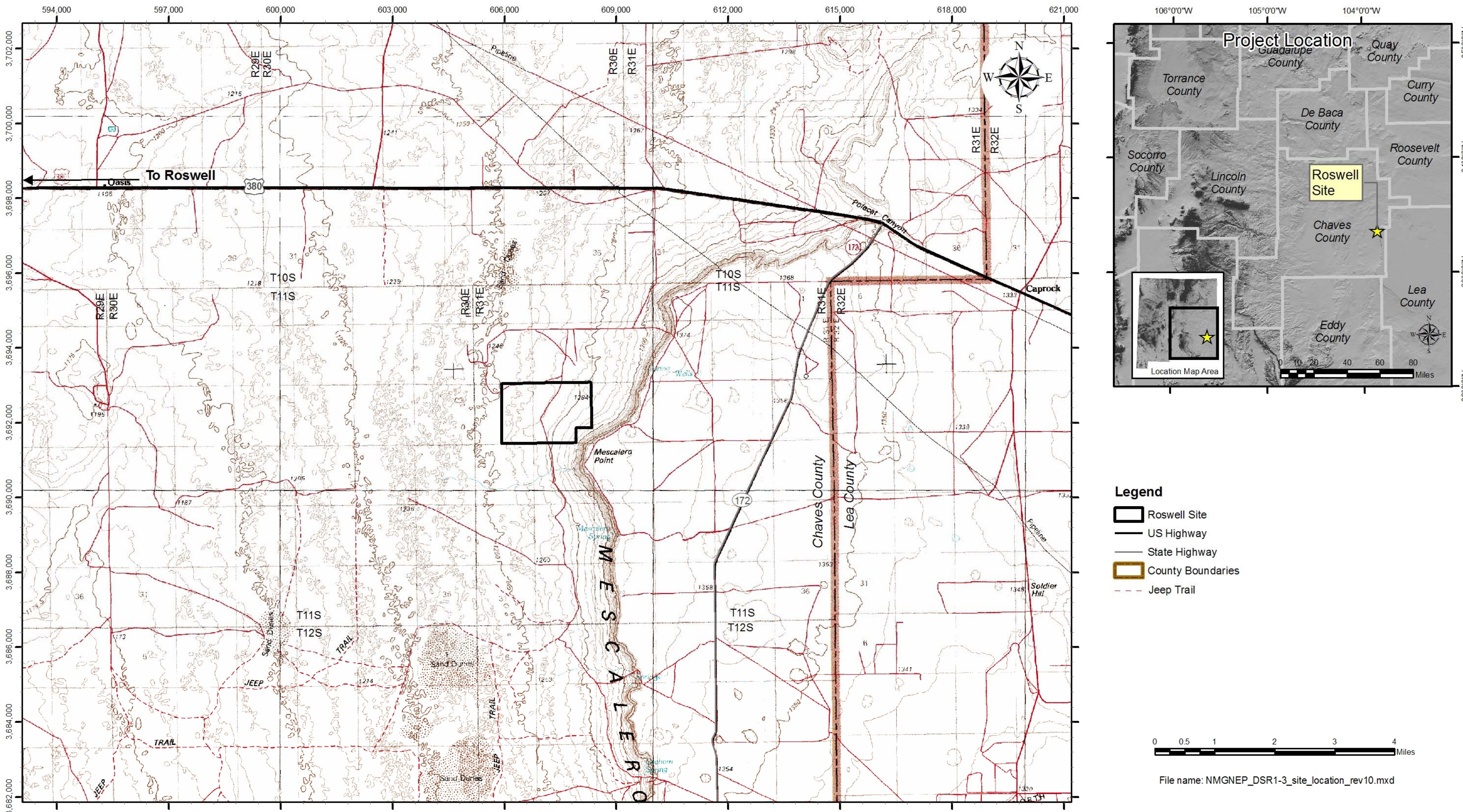

Figure 1-3. Location of the Roswell site by township, range, section, and UTM coordinates (1-010, 1-019, 1-021, 1-026, 1-032, 1-034).

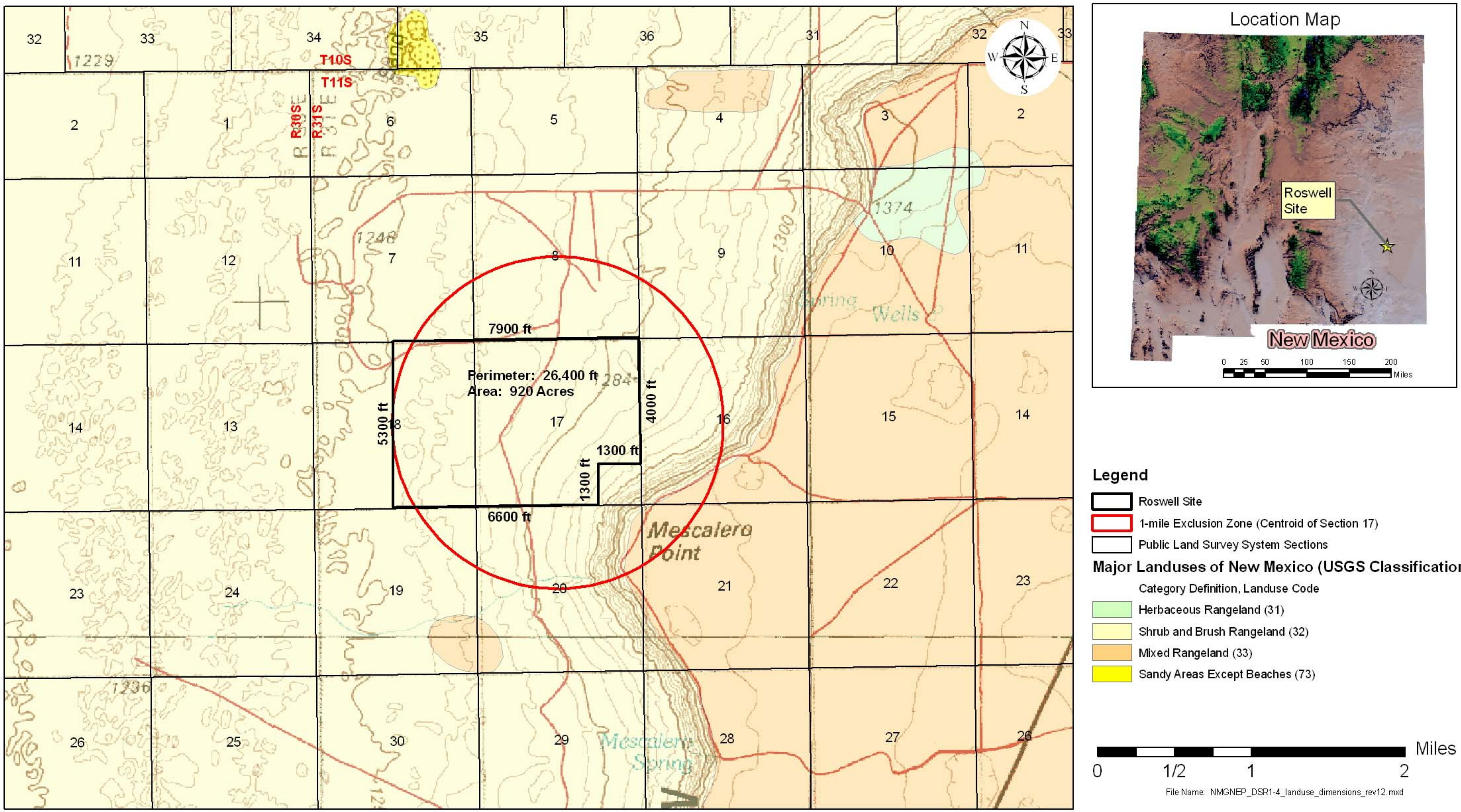

Figure 1-4. Roswell site boundary linear perimeter dimensions, land use type, and exclusion zone (1-005, 1-019, 1-021, 1-033, 1-052).

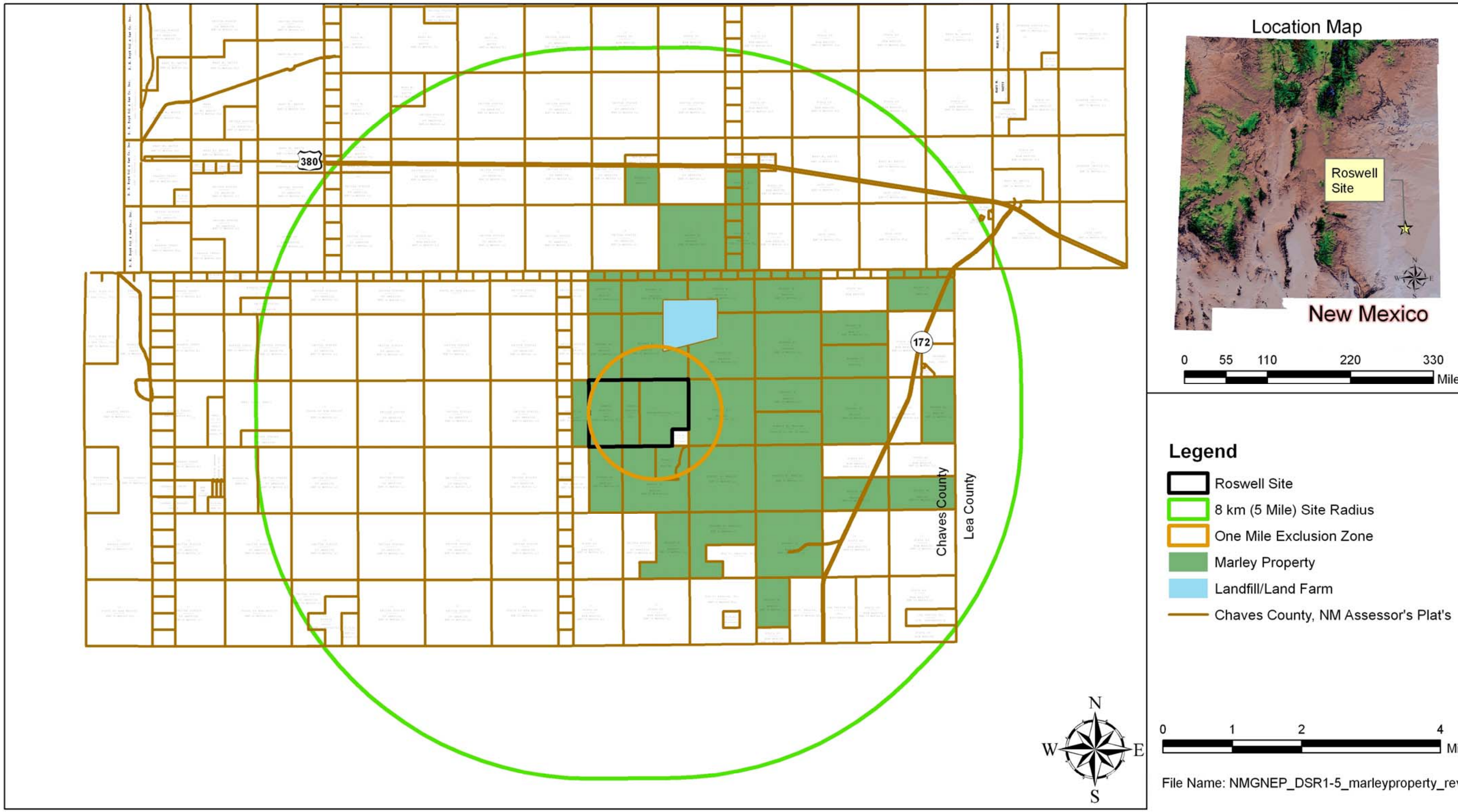

Figure 1-5. Location of property owned by Robert W. Marley in the vicinity of the Roswell site (1-015, 1-018, 1-021, 1-025, 1-026, 1-032, 1-033, 1-052).

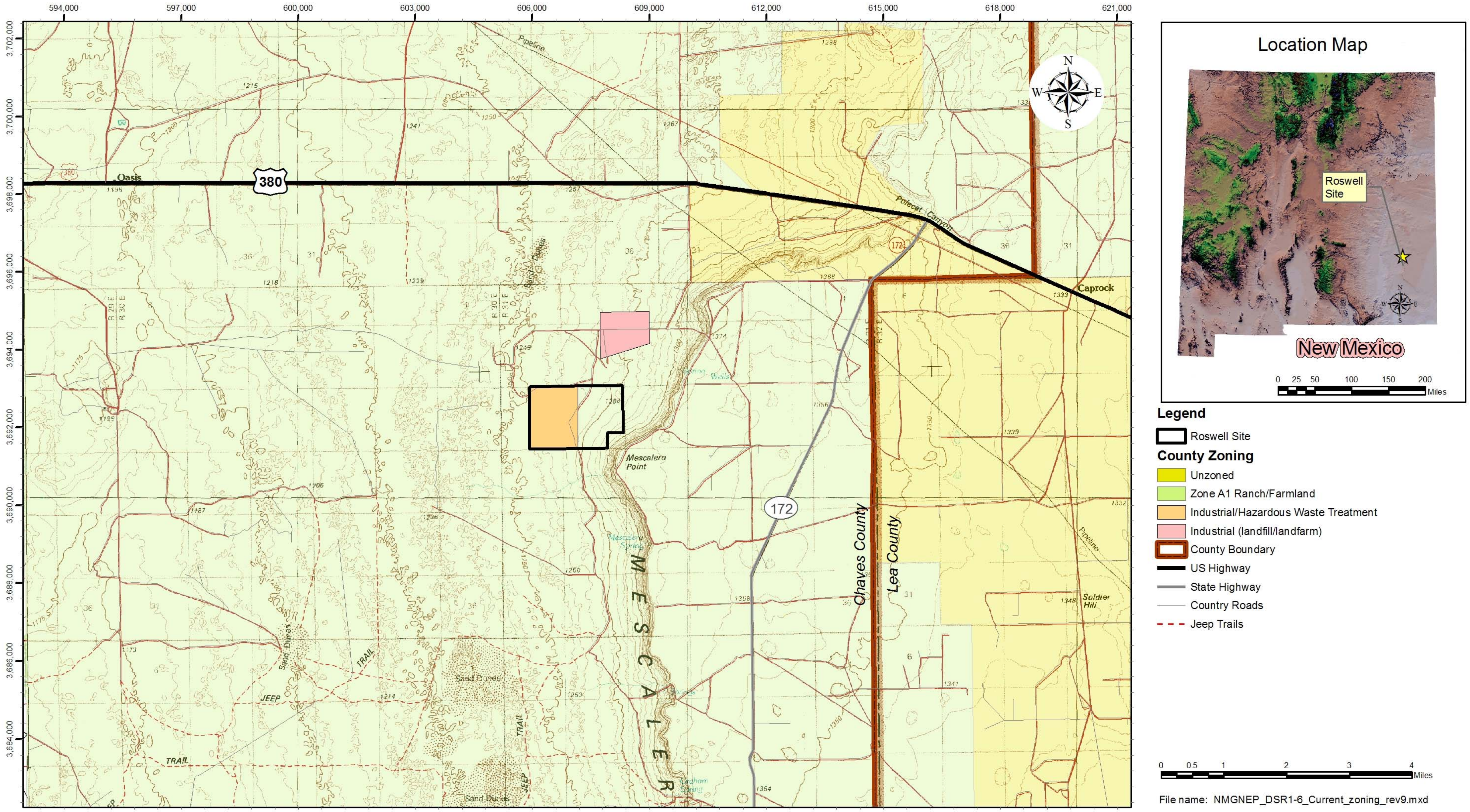

Figure 1-6. Current Roswell site zoning and transportation routes (local highway, improved and unimproved roads) (1-006, 1-009, 1-010, 1-013, 1-015, 1-019, 1-021, 1-026, 1-030, 1-032, 1-034, 1-038).

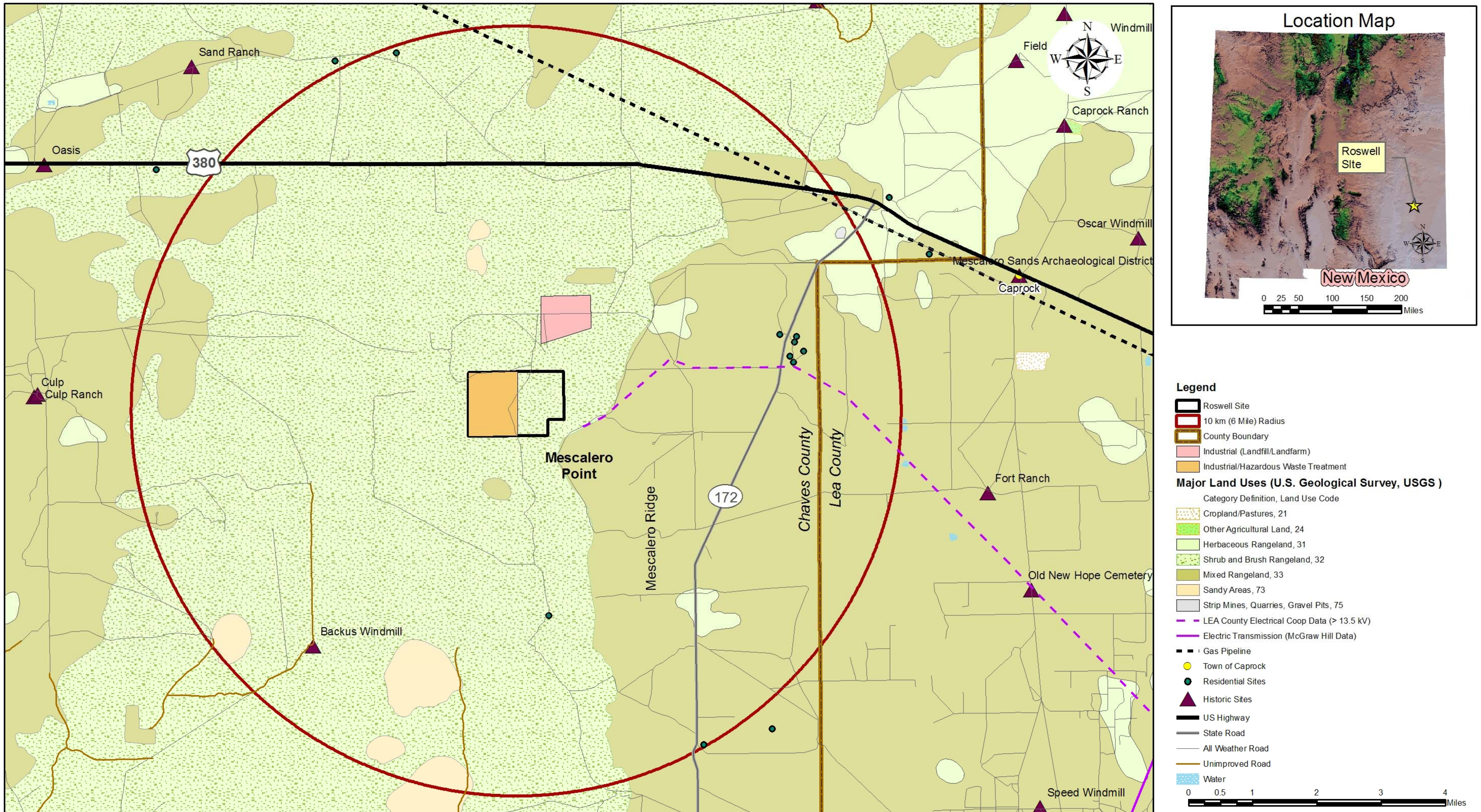

Figure 1-7. Required Roswell site characteristics located within the 10-kilometer (6-mile) buffer (1-002, 1-005, 1-006, 1-007, 1-009, 1-010, 1-011, 1-015, 1-017, 1-019, 1-020, 1-021, 1-023, 1-026, 1-028, 1-029, 1-030, 1-032, 1-038, 1-053).

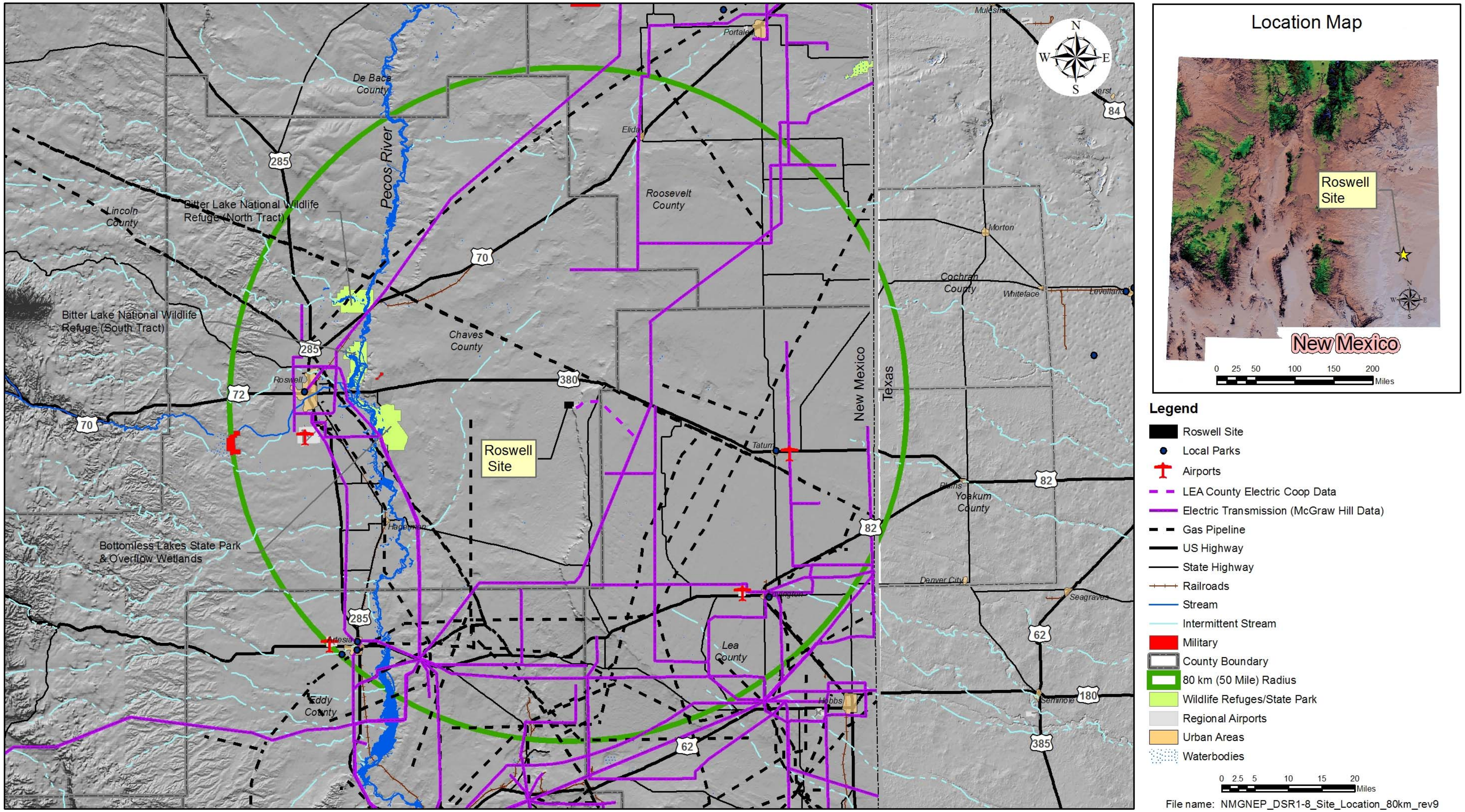

Figure 1-8. Required Roswell site characteristics located within the 80-kilometer (50-mile) buffer (1-003, 1-008, 1-010, 1-012, 1-016, 1-019, 1-021, 1-022, 1-024, 1-026, 1-027, 1-028, 1-029, 1-031, 1-032, 1-035, 1-036, 1-037, 1-039, 1-041, 1-045, 1-046, 1-050, 1-053).

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CONTENTS

FIGURES

TABLES

10. WEATHER / CLIMATOLOGY

This section provides an overview (Section 10.1), information about regional meteorology (Section 10.2), site-specific meteorology based on data from meteorological stations near the Roswell site (Section 10.3), and information on extreme weather that has occurred near the site (Section 10.4). Air quality is discussed in Section 10.5. The regional and site-specific meteorological information provided includes temperature, precipitation, and wind data. The extreme weather events considered are tornados and hurricanes. Air quality information includes air quality standards and non-attainments areas in New Mexico.

10.1 Overview and Summary

The Roswell site is at a remote location that has no site-specific meteorological data. Nevertheless, climatological data at six nearby National Weather Service (NWS) stations for the most recently available 30 years (1971-2000) were reviewed and are summarized below. This information represents the best available data to support analysis of potential environmental impact of constructing and operating the proposed GNEP facilities. Review of the weather and climatological conditions surrounding the Roswell site over the 30-year period led to the conclusions that:

- The site location has a mild, arid to semiarid, continental climate. The normal daily average temperature ranges from 38.0°F in January to 80.8°F in July; the normal precipitation ranges from 0.34 inch in January to 3.06 inch in July; and the normal wind speed ranges from 6.9 mph in December/January to 9.8 mph in April.

- Occasional extremely low temperature (approximately -23°F) in the winter, and high wind speed in the summer in Roswell (over 73 mph, 40 miles W from the Roswell site), may limit construction activities at the site. Effective work planning and scheduling can mitigate the impact of those extreme weather conditions.

- The topography in the area is characterized by gently down-sloping topography to the west, a 200-ft abrupt change in elevation along the Mescalero Ridge through the center and uniform topography to the east and does not appear to have a major influence on local climate.

- New Mexico, in general, has no instances of hurricanes; the site is inland and does not border on any major coastline. Any hurricane moving over land will quickly diminish and downgrade to heavy rains.

- The likelihood of a tornado occurring within any 1,000 square mile area in New Mexico is very small. New Mexico has on average nine tornadoes per year.

- There are no non-attainment areas for the National Ambient Air Quality Standards (NAAQS) within a 50-mile radius of the site.

- There is no evidence of severe environmental consequences associated with the weather/climatology for the construction and operation of the GNEP facilities.

10.2 Regional Meteorology

New Mexico has a mild, arid to semiarid, continental climate (10-007). Generally clear skies and low humidity throughout the state allow for abundant sunshine during the day, radiational cooling at night, high evaporation rates, and light precipitation totals. New Mexico has abundant sunshine throughout the year, with 75 to 80 percent of the possible sunshine being received. In winter, this is particularly noticeable with from 70 to 75 percent of the possible sunshine being received.

10.2.1 Temperature

Mean annual temperatures range from 64°F in the extreme southeast to less than 40°F in the high mountains and valleys of the north; elevation is a greater factor in determining the temperature of any specific location than its latitude. This is shown by only a three degree difference in mean temperature between stations at similar elevations, one in the extreme northeast and the other in the extreme southwest; however at two stations only 15 miles apart, but differing in elevation by 4,700 feet, the mean annual temperatures are 61 and 45°F; a difference of 16 degrees or a little more than 3 degrees decrease in temperature for each 1,000-foot increase in elevation.

During the summer months, individual daytime temperatures often exceed 100°F at elevations below 5,000 feet; but the average monthly maximum temperatures during July, the warmest month, range from slightly above 90°F at lower elevations to the upper 70s at high elevations. The highest temperature of record in New Mexico is 122°F set at the Waste Isolation Pilot Plant (WIPP) in Eddy County on June 27, 1994. A preponderance of clear skies and low relative humidity permit rapid cooling by radiation from the earth after sundown; consequently nights are usually comfortable in summer. The average range between daily high and low temperatures is from 25 to 35°F.

In January, the coldest month, average daytime temperatures range from the middle 50s in the southern and central valleys to the middle 30s in the higher elevations of the north. Minimum temperatures below freezing are common in all sections of the State during the winter, but subzero Fahrenheit temperatures are rare except in the mountains. The lowest temperature recorded at regular observing stations in the State was -50°F at Gavilan (Rio Arriba County) on February 1, 1951.

The freeze-free season ranges from more than 200 days in the southern valleys to less than 80 days in the northern mountains where some high mountain valleys have freezes in summer months.

10.2.2 Precipitation

Average annual precipitation ranges from less than 10 inches over much of the southern desert and the Rio Grande and San Juan valleys to more than 20 inches at the higher elevations in the State. Annual averages of 5 inches or less occur within a narrow band along the Rio Grande and San Juan River valleys in the west-central part of the state. The highest mountains average 30 inches or more. Potential evaporation is much greater than average annual precipitation, ranging from near 56 inches in the north-central mountains to more than 110 inches in southeastern valleys with approximately 70 percent occurring during the months of May through October. A wide variation in annual precipitation totals is characteristic of arid and semiarid climates as illustrated by annual extremes of 2.95 inches and 33.94 inches at Carlsbad during a period of more than 71 years.

Summer rains fall almost entirely during brief, but frequently intense, thunderstorms. The general southeasterly circulation from the Gulf of Mexico brings moisture for these storms into the State, and strong surface heating combined with orographic lifting as the air moves over higher terrain causes air currents and condensation. July and August are the rainiest months over most of the state with from 30 to 40 percent of the year's total moisture falling during these months. The San Juan valley area is least affected by this summer circulation, receiving about 25 percent of its annual rainfall during July and August. During the warmest 6 months of the year, May through October, total precipitation averages 60 percent of the annual total in the eastern plains.

Winter precipitation is caused mainly by frontal activity associated with the general movement of Pacific Ocean storms across the country from west to east. As these storms move inland, much of the moisture is precipitated over the coastal and inland mountain ranges of California, Nevada, Arizona and Utah. Much of the remaining moisture falls on the western slope of the Continental Divide. This dryness is most noticeable in the Central Valley and on eastern slopes of the mountains.

Much of winter's precipitation falls as snow in the mountain areas, but rain or snow may occur in the valleys. Average annual snowfall ranges from about three inches at southern desert and southeastern plains sites to well over 100 inches at northern mountain stations. It may exceed 300 inches in the highest mountains of the north.

10.2.3 Winds

Winds across the state are generally from the southeast in summer and from the west in winter, but local surface wind directions vary greatly due to local topography such as the orientation of mountain ranges and valleys. Winds are also generally stronger in the eastern plains than in other parts of the state. The winter months are characterized by frontal activity associated with low-pressure systems moving inland off the Pacific Ocean. Most of the moisture from these systems is precipitated out as they cross the mountain ranges of California and Arizona, resulting in the winter months being the driest. The summer air flow brings moisture from the Gulf of Mexico along with brief but frequent afternoon convective storms. These storms are responsible for most of the annual precipitation.

10.3 Site-Specific Meteorology

The NOAA National Climatic Data Center (NCDC) has a responsibility to fulfill the mandate of Congress "... to establish and record the climatic conditions of the United States." This responsibility is part of a provision of the Organic Act of October 1, 1890, which established the Weather Bureau as a civilian agency (15 U.S.C. 311). In accordance with national and international convention, the average value of a meteorological element over 30 years is defined as a climate normal, and is used as a comparative basis for current conditions. Every 10 years, NCDC computes new 30-year climate normals for selected temperature and precipitation elements for a large number of U.S. climate and weather stations.

Site-specific meteorological data are not available for the Roswell site, and therefore, climate data from nearby meteorological observing stations were used to represent climate conditions at the Roswell site. Table 10-1 lists the six nearest stations managed by the NWS for which the most recent 30-year climate normals (i.e., 1971 to 2000) have been calculated by the NCDC. The station locations relative to the Roswell site are shown in Figure 10-1. The Roswell airport station is the closest first-order station to the site and is part of the Automated Surface Observing System (ASOS) that is the primary weather observing network in the U.S. First-order weather stations, which are generally located at major locations such as airports and military bases, record a complete range of meteorological parameters. The other stations in Table 10-1 are part of the NWS Cooperative Observer Program (COOP); a nationwide weather and climate monitoring network of 11,700 trained volunteer citizens and institutions observing and reporting weather information on a 24-hour basis. COOP observations form the backbone of temperature and precipitation records describing U.S. climate. First-order stations are also included as part of the COOP network, which is why the Roswell station has a COOP ID. All stations in Table 10-1 measure and record temperature and precipitation, but only the Roswell station records wind speed and direction.

Table 10-1. Weather stations with 1971-2000 climate summaries near the Roswell site (10-002, 10-004).

Station Name	Station Type[a]	COOP ID	WBAN ID[b]	Period of Record[c]	Lat / Long (deg:min)	Elevation (feet)[d]	Distance and Direction from the Roswell Site[e]
Bitter Lakes Wildlife Refuge	COOP	290992	-	1950 - present	33°28’/104°24’	3,664	33 mi WNW
Roswell FAA Airport	ASOS	297610	23009	1920 - present	33°18’/104°32’	3,650	40 mi W
Maljamar 4 SE	COOP	265370	-	1942 - 2000	32°49’/103°42’	4,000	39 mi SSE
Tatum	COOP	298713	-	1919 - present	33°16’/103°19’	4,100	32 mi ESE
Crossroads #2	COOP	292207	-	1929 - 2001	33°31’/103°21’	4,150	31 mi NE
Elida	COOP	292854	-	1914 - 2006	33°57’/103°39’	4,354	42 mi NNE

a. COOP = Cooperative Observing Program station, ASOS = Automated Surface Observing Station.
b. Weather Bureau, Army, and Navy meteorological station identifier
c. NCDC Monthly Station Climate Summaries (1971-2000) are available for this site.
d. For comparison, the elevation at the Roswell site ranges approximately from 4,100-4,200 feet.
e. Distance based on the Roswell site center coordinates of 33° 21’ 52.2” N / 103° 50’ 55.0” W.

These stations are distributed in an approximate circle surrounding the Roswell site. The nearest station is 31 miles from the Roswell site. Given the distribution and distances of these stations relative to the Roswell site, it is not possible to single out one station as the most representative of the conditions at the site. Instead, the climate normals and extremes for all these stations are given in Tables 10-2 through 10-4 to represent the possible range of climate conditions at the site. A review of the climate data in these tables reveals some variability from station to station. The topography in this area is characterized by gently down-sloping topography in the west, an abrupt 200-foot change in elevation along the Mescalero Ridge through the center, and uniform topography in the east. These topographic elements are not extreme and do not appear to have a major influence on local climate. Although there is a 700-foot elevation difference across the 70 miles between the Roswell and Tatum stations, this is much less dramatic than the 4,700-foot elevation change across 15 miles (mentioned above in the state climate summary) where a significant climatic variation is observed.

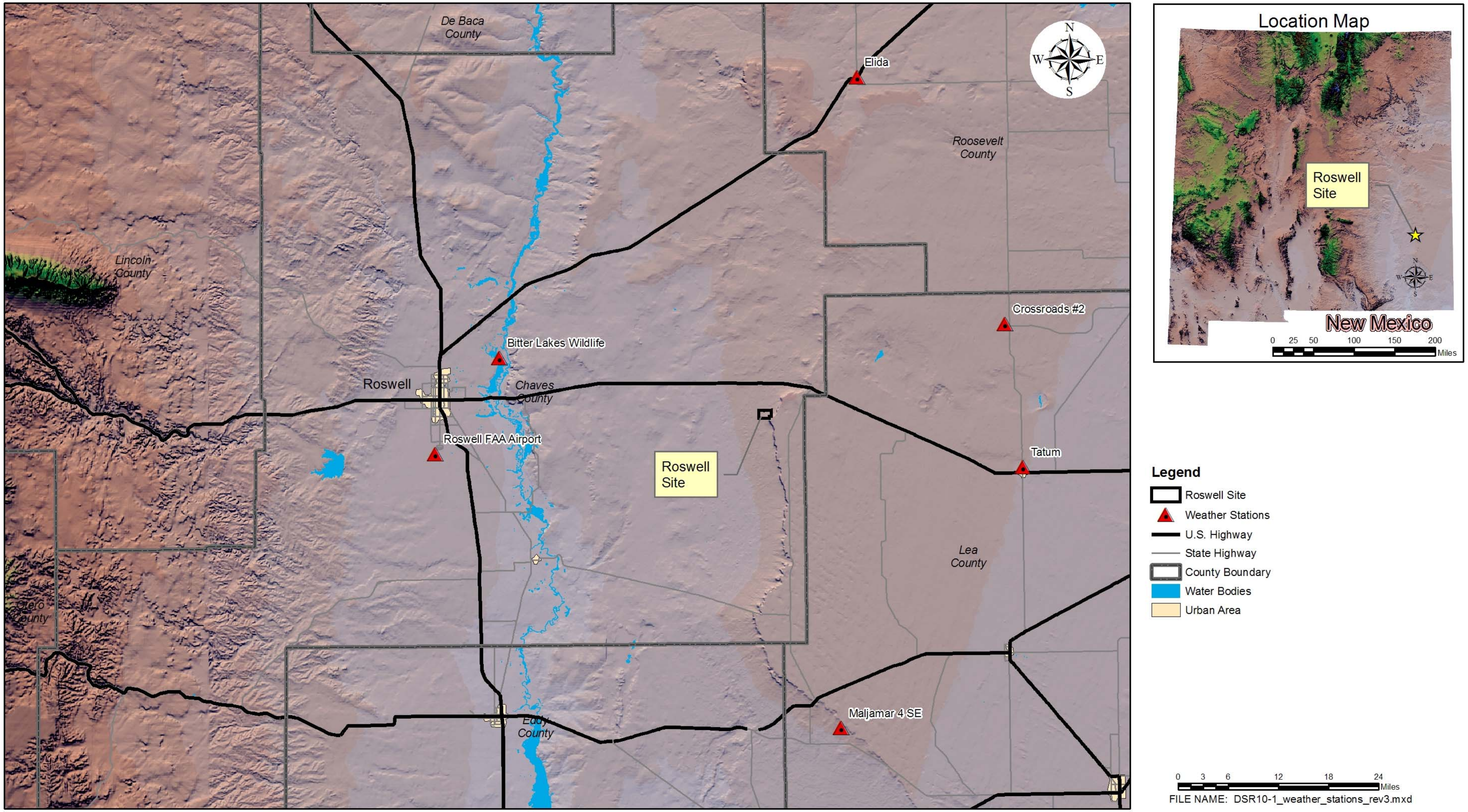

Figure 10-1. Weather stations with 1971-2000 climate summaries near the Roswell site (10-029).

Table 10-2. Roswell site climate: temperature data recorded at nearby meteorological stations (10-002, 10-006).

Station Name	Temperature (°F)	POR[a]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bitter Lakes WR	Extreme High	52	85	89	95	100	110	114	112	107	106	101	89	85	114
	Normal High	30	55.4	61.4	69.6	77.4	85.8	93.6	94.9	92.9	86.1	77.0	65.1	56.2	76.3
	Average	30	38.1	43.3	50.9	58.8	68.0	76.4	79.3	77.4	70.2	59.1	47.0	38.5	58.9
	Normal Low	30	20.8	25.2	32.1	40.2	50.2	59.2	63.7	61.9	54.2	41.1	28.9	20.7	41.5
	Extreme Low	52	-22	-12	5	16	24	39	40	40	30	10	-3	-11	-22
Roswell Airport	Extreme High	33	82	85	93	99	107	114	111	107	103	99	88	81	114
	Normal High	30	55.6	62.0	70.0	77.7	86.0	94.0	94.8	92.3	85.7	76.5	64.5	56.3	76.3
	Average	30	40.0	45.7	52.9	60.5	69.6	78.0	80.8	78.9	72.0	61.4	48.9	40.7	60.8
	Normal Low	30	24.4	29.3	35.7	43.3	53.2	62.0	66.7	65.5	58.3	46.3	33.3	25.1	45.3
	Extreme Low	33	-9	3	9	23	34	47	59	54	40	14	4	-8	-9
Maljamar 4 SE	Extreme High	53	84	85	92	100	109	116	111	109	107	98	86	79	116
	Normal High	30	56.0	62.1	70.0	78.3	86.4	94.2	95.5	93.0	86.6	77.2	64.9	56.9	76.8
	Average	30	40.5	45.5	52.6	60.6	69.3	77.2	79.5	77.8	71.5	61.4	49.4	41.6	60.6
	Normal Low	30	25.0	28.8	35.2	42.9	52.1	60.2	63.5	62.6	56.4	45.6	33.8	26.2	44.4
	Extreme Low	53	-13	-10	4	19	30	41	49	50	30	16	-4	-3	-13

Table 10-2. (continued).

Station Name	Temperature (°F)	POR (1)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Tatum	Extreme High	54	82	86	92	97	107	115	110	107	105	98	86	82	115
	Normal High	30	53.8	59.1	66.8	74.3	82.4	90.3	91.3	89.5	82.8	74.7	62.8	54.7	73.5
	Average	30	38.7	42.9	49.3	57.1	66.2	74.5	77.0	75.4	68.5	58.8	47.0	39.5	57.9
	Normal Low	30	23.5	26.6	31.8	39.9	49.9	58.6	62.7	61.2	54.2	42.8	31.1	24.3	42.2
	Extreme Low	54	-16	-15	2	10	27	39	49	46	28	11	0	-8	-16
Crossroads #2	Extreme High	54	79	84	90	97	101	109	108	103	102	97	85	78	109
	Normal High	30	53.9	59.2	66.7	74.5	82.6	90.1	91.5	89.2	82.8	74.5	62.7	54.8	73.5
	Average	30	38.0	42.3	49.1	57.2	66.3	74.5	76.9	75.1	68.4	58.6	46.8	38.9	57.7
	Normal Low	30	22.1	25.4	31.5	39.8	49.9	58.8	62.2	61.0	53.9	42.6	30.8	23.0	41.8
	Extreme Low	54	-23	-7	6	18	23	43	52	48	32	10	5	-8	-23
Elida	Extreme High	54	79	83	90	98	110	112	111	105	104	98	85	77	112
	Normal High	30	52.5	57.9	66.2	74.3	82.6	90.4	91.0	88.6	83.1	73.7	61.5	53.4	72.9
	Average	30	38.9	43.3	50.2	58.0	67.1	75.3	77.7	75.8	69.4	59.5	47.4	39.8	58.5
	Normal Low	30	25.3	28.7	34.2	41.7	51.5	60.1	64.3	63.0	55.7	45.3	33.2	26.1	44.1
	Extreme Low	54	-19	-17	1	15	27	34	41	42	27	10	2	-11	-19

a. Period of Record (POR) identified in the reference documentation (see below) for use in determining climate conditions for this weather element.

Table 10-3. Roswell site climate: precipitation data recorded at nearby meteorological stations (10-002, 10-006).

Station Name	Precipitation (inches)	POR[a]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual[b]
Bitter Lakes WR	Extreme High	52	1.46	1.96	1.72	3.06	7.71	5.96	7.75	7.19	5.68	5.61	2.08	2.53	-
	Normal	30	0.41	0.45	0.35	0.51	1.25	1.72	2.14	2.52	1.96	1.34	0.68	0.57	13.90
	Extreme Low	52	0	0	0	0	0	0	0.14	0.03	0.09	0	0	0	-
Roswell Airport	Extreme High	33	1.03	2.02	2.84	2.89	4.57	5.02	6.88	6.48	6.58	5.91	2.95	3.07	-
	Normal	30	0.39	0.41	0.35	0.58	1.30	1.62	1.99	2.31	1.98	1.29	0.53	0.59	13.34
	Extreme Low	33	0.03	0	0	0.01	T	0.02	0.01	0.07	0.05	T	0	0	-
Maljamar 4 SE	Extreme High	53	1.60	1.86	1.83	2.34	7.69	5.85	6.74	10.88	7.71	4.78	1.85	3.70	-
	Normal	30	0.44	0.49	0.41	0.53	1.81	1.76	2.29	2.79	3.06	1.17	0.67	0.66	16.08
	Extreme Low	53	0	0	0	0	0	0	0	0	0	0	0	0	-
Tatum	Extreme High	54	1.59	1.90	2.26	2.52	8.82	6.95	6.37	9.62	7.10	9.67	2.24	2.60	-
	Normal	30	0.36	0.37	0.53	0.49	2.02	2.20	2.43	2.87	2.79	1.41	0.73	0.51	16.71
	Extreme Low	54	0	0	0	0	0	0	0.27	0.17	0.10	0	0	0	-
Crossroads #2	Extreme High	54	1.59	1.53	1.84	2.24	6.25	4.87	8.45	8.35	5.08	6.66	2.26	3.29	-
	Normal	30	0.34	0.36	0.37	0.60	1.99	1.97	2.65	2.87	2.18	1.42	0.61	0.48	15.84
	Extreme Low	54	0	0	0	0	0	0.20	0.12	0.02	0	0	0	0	-
Elida	Extreme High	54	2.28	1.68	2.00	3.92	5.92	5.90	11.05	6.99	6.31	5.52	2.43	2.05	-
	Normal	30	0.51	0.37	0.43	0.72	1.43	2.26	3.06	2.49	2.14	1.37	0.75	0.54	16.07
	Extreme Low	54	0	0	0	0	0	0	0.46	0	0	0	0	0	-

a. Period of Record (POR) identified in the reference documentation (see below) for use in determining climate conditions for this weather element.
b. Precipitation extremes are provided in the NCDC Monthly Station Climate Summaries for maximum in 24-hours, maximum monthly, and minimum monthly. Maximum and minimum annuals are not provided.

Table 10-4. Roswell site climate: wind speed and direction recorded at the Roswell Meteorological Station (10-003, 10-006).

Station Name	Wind Speed	POR[a]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Wind Speed (mph)															
Roswell Airport[b]	Extreme High	19	54	56	55	64	60	73	59	55	51	52	65	58	73
	Average	42	6.9	8.1	9.5	9.8	9.6	9.6	8.5	7.7	7.6	7.3	7.2	6.9	8.2
Prevailing Wind Direction (degrees)															
Roswell Airport[b]	-	260	160	160	160	160	150	160	150	140	160	160	160	160	160

a. Period of Record (POR) identified in the reference documentation (see below) for use in determining climate conditions for this weather element.
b. Wind data are only available for the Roswell Airport station.

10.3.1 Temperature

Temperature data from six meteorology stations near the site are presented in Table 10-2. At these stations, the normal daily temperatures in January, the coldest month, range from lows of 21 to 25°F to highs of 52 to 56°F. In July, the hottest month, they range from lows of 62 to 67°F to highs of 91 to 96°F. The extreme recorded temperatures are a low of -23°F and a high of 116°F.

10.3.2 Precipitation

Precipitation data from six meteorological stations near the site are presented in Table 10-3. At these stations, monthly precipitation totals are generally lowest between late fall and early spring (November through April), and are highest between late spring and early fall (May through October).

10.3.3 Winds

Wind speed and direction data from the Roswell Airport meteorological stations are presented in Table 10-4. The average wind speed is lowest in early winter (December and January) and highest in the spring (March through May), but there is little difference between the monthly averages (6.9 to 9.8 mph). The prevailing wind direction is from the south to southeast (140 to 160 degrees). Although monthly average wind speeds are less than 10 mph, much higher winds have been recorded. The highest wind speeds recorded range from 51 mph in September to 73 mph in June.

10.4 Extreme Weather

Severe weather includes tornadoes, large hail, and strong winds. While severe weather in New Mexico is rare, hail ranks as the most frequent type of severe weather and is responsible for a considerable percentage of property and crop damage. Hail and tornadoes can only occur with thunderstorms. Although thunderstorms are relatively frequent in summer, averaging from 40 per year in the south to 70 per year in the northeast, the entire state averages only nine to 10 tornadoes per year and most commonly across the Eastern Plains. Tornadoes and severe hail events peak in May and June, while high wind events peak in June and July. There is little report of damage due to tornado winds because most tornadoes in the State are weak and occur in sparsely populated areas. On occasion, tropical storm remnants affect the southern and central parts of the state with heavy rains, but wind from these systems rarely causes significant damage. Other significant weather events including flash floods, lightning, microbursts (wet or dry) and dust devils are not considered “severe weather” by NWS definition, but are a frequent and often dangerous aspect of New Mexico’s weather (10-010).

10.4.1 Hurricanes

A hurricane is a severe tropical storm that forms in the warm waters of the North Atlantic Ocean, Gulf of Mexico, or Northeast Pacific Ocean. In order to be sustained, hurricanes need warm tropical oceans, moisture at low levels in the atmosphere, and light winds in the upper atmosphere above them. Under the right conditions, a hurricane is capable of producing violent winds, large waves, torrential rains, and floods. While over the ocean, hurricanes generally do not pose a threat. It is not until these storms approach the coastline and move inland that their impact on human interests is felt. Once over land, the severe high winds tend to subside quickly and the threat shifts to heavy rain and flooding.

The intensity of a hurricane is estimated using the Saffir-Simpson Hurricane Scale, which ranks potential property damage and flooding expected along the coast from a hurricane landfall. With wind being the primary factor in the scale, the weakest hurricanes are rated as Category 1 while the most intense are rated as Category 5 (see Table 10-5).

Table 10-5. Saffir-Simpson hurricane scale (10-009).

Scale Value	Wind Speed (miles per hour)	Storm Surge (feet)	Damage Potential
Category 1	74-95	4-5	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.
Category 2	96-110	6-8	Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers.
Category 3	111-130	9-12	Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed.
Category 4	131-155	13-18	More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows.
Category 5	>155	>18	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage.

Two sources of information are available for evaluating United States hurricane strike probabilities and historical hurricane tracks:

- The United States Landfalling Hurricane Probability Project, conducted by Colorado State University in 2004, calculated probabilities of landfalling tropical cyclones along the United States coastline from Brownsville, Texas to Eastport, Maine (10-008).
- Historical Hurricane Tracks interactive website tool supported by the NOAA Coastal Services Center that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data (10-005).

Since New Mexico is an inland state that does not border on any major coastline, the landfall probabilities presented by the United States Landfalling Hurricane Probability Project cannot be applied to the Roswell site. The nearest study area in the project (i.e., the Texas coastline) is over 500 miles from the Roswell site.

While New Mexico cannot directly experience a landfalling hurricane, the state can still be affected by hurricanes that move inland. The intensity of any hurricane moving over land toward the Roswell site will quickly diminish as it encounters friction and loses low-level support of tropical moisture and warm ocean waters. A hurricane will be downgraded to tropical storm, tropical depression, or extra-tropical low pressure system as it continues to lose strength. Heavy rains and flooding under the storm remnants may persist for days after landfall, and may occur hundreds of miles inland.

Historically, tropical storms have occasionally approached the site from both the southwest (Pacific storms) and the southeast (Gulf of Mexico storms). Figure 10-2 presents results of the Historical Hurricane Tracks website tool that was queried to show tracks of all tropical storms that have crossed into New Mexico since records have been kept, that is, since 1851 for Atlantic storms and since 1949 for Pacific storms. There is no recorded track that brought the center of a tropical storm within 200 miles of the Roswell site. Based on this analysis of storm tracks, the Roswell site has never experienced tropical-force winds associated with a tropical storm.

10.4.2 Tornados

According to the American Meteorological Society (AMS) Glossary of Meteorology, a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." In order for a vortex to be classified as a tornado, it must be in contact with the ground and the cloud base (10-012).

Intensities of tornadoes occurring in the United States have been estimated using the original Fujita Scale, or F-scale, which ranks tornadoes based on the level of observable damage: F0 being the weakest and F5 the strongest. An enhanced version of the F-scale was implemented in February 2007. Both F-scales are presented in Table 10-6 and relate observed damage to estimated wind speed (10-011).

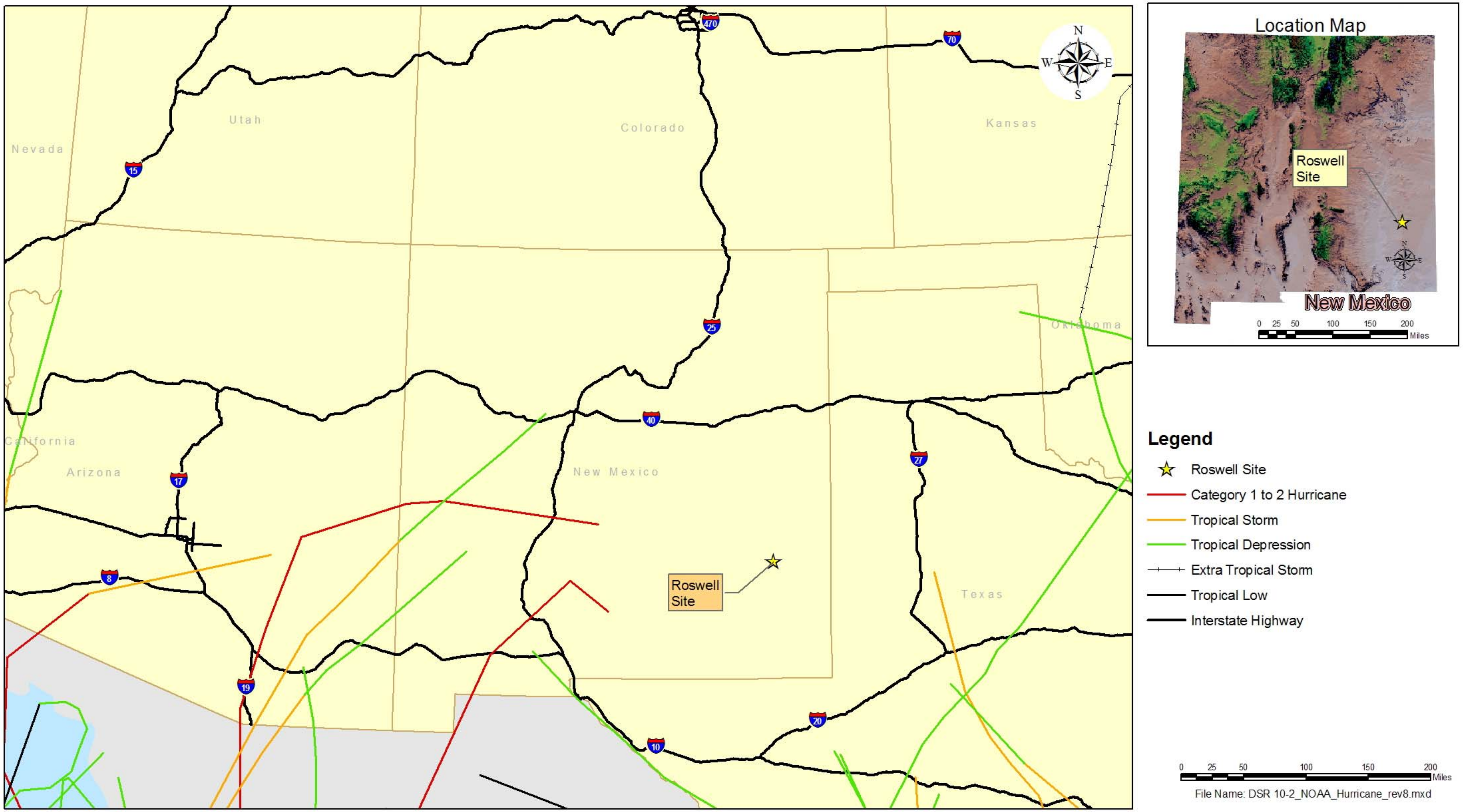

Figure 10-2. Historical hurricane tracks (10-019, 10-020, 10-023, 10-024, 10-025).

Table 10-6. Fujita tornado scales (10-011).

Original Fujita Scale			Enhanced Fujita Scale		
Scale Value	**Fastest 1/4-mile (mph)**	**3-Second Gust (mph)**	**Scale Value**	**3-Second Gust (mph)**	**Structural Damage Description**
F0	40-72	45-78	EF0	65-85	Little Damage
F1	73-112	79-117	EF1	86-110	Minor Damage
F2	113-157	118-161	EF2	111-135	Roof Gone
F3	158-206	162-209	EF3	136-165	Walls Collapse
F4	207-260	210-261	EF4	166-200	Blown Down
F5	261-318	262-317	EF5	>200	Blown Away

Direct wind speed and pressure drop measurements within tornadoes are not possible or practical, with only a handful of known cases where weather instruments survived a direct hit by a tornado (10-012). The Enhanced F-scale uses 3-second gust estimates at the point of damage based on eight levels of damage using 28 indicators. The "fastest ¼ mile" and the "3-second gust" cannot be equated to standard surface wind observations of peak wind, which are based on 5-second and 2-minute averages. These different statistical measures of wind speed presented in the F-scales are not intended to be compared against one another. Instead, each provides a basis for correlating wind loading to observed tornado damage.

The average probability of tornado occurrence within the entire state of New Mexico is nine per year (10-010), ranking New Mexico as the 28th of the 50 states in terms of tornado incidence statewide and 40th in terms of tornado incidence per square mile (10-013).

With a total area covering 121,355 square miles, the annual average probability of a tornado occurring within any 1,000-square mile area in New Mexico can be approximated as:

$$\frac{9\ tornadoes\ per\ year}{121{,}355\ sq\ mi} = \frac{0.07\ tornadoes\ per\ year}{1{,}000\ sq\ mi}$$

This ratio is an oversimplification because it assumes an even distribution of tornadoes within the State. In reality, reports of severe weather occur most frequently in the extreme eastern counties of New Mexico. Plus, the frequency and intensity of tornadoes is correlated more strongly with thunderstorm characteristics, which tend to vary across the state, than with the frequency of thunderstorms. Across the eastern plains, thunderstorms often develop in an environment with low-level moist inflow from the southeast beneath a west or northwest flow at mid- and high-levels of the troposphere. Thunderstorms generated under these conditions tend to be better organized, long-lived, and more likely to produce severe weather. The Roswell site, being in the eastern plains, is most likely to experience this type of storm. In contrast, thunderstorms in the west are associated with the "Southwest Monsoon" and tend to be less severe, occasionally producing flash floods and prolific small hail accumulations.

New Mexico has an extremely low population density with some counties having less than five persons per square mile. This has likely resulted in many severe weather events being not observed or not reported, especially if these occurred away from population centers of the larger cities. In sparsely populated areas, the lack of structures makes application of the Fujita Scale difficult. Despite this, existing observations indicate that a very high percentage of reported tornadoes in the state are weak (F0 or F1) with less than 5 percent assigned intensities in the strong category (F2 or F3) (10-010).

Detailed information on tornado events that have occurred on or near the Roswell site was obtained from:

- The NCDC Storm Event Database, which is a publicly available online storm event database that has search capabilities based on location, time period, and storm type. Event summaries and details are available by state, county, time period, and event type. At the time of access, the database contained reported storm events from January 1, 1950 through October 31, 2006 (10-001).

The climatological state-wide probability of tornado occurrence in New Mexico is nine tornadoes per year. To better evaluate the probability of tornado occurrence in southeastern New Mexico, where the Roswell site is located, several queries of the NCDC Storm Event Database were performed for tornado events:

- State-wide for the period January 1, 1950 to October 31, 2006 in order to verify the completeness of the NCDC Storm Events Database by comparing these results to the climatological state-wide annual average.

- Southeastern Counties for the period January 1, 1950 to October 31, 2006 in order to focus on the extreme eastern part of the state where severe weather occurs most frequently.

- Chaves and Lea Counties for the period November 1, 2001 to October 31, 2006 in order to assess probability of tornado occurrence within 1,000 square miles of the Roswell site over the past 5 years.

The results of the first two queries, presented in Table 10-7, show that a total of 485 tornadoes was reported state-wide over the past 57 years; an average of 8.66 tornadoes per year. This closely matches the climatological average of nine per year. The eight southeastern counties account, on average, for 5.18 of these tornadoes per year. In other words, 60 percent of the tornadoes, on average, occur within the southeast 27 percent of the State’s land area. This is consistent with the statement that severe weather is more common in the extreme eastern part of the state. The closest two counties surrounding the Roswell site are Chaves County and Lea County which report, on average, 0.73 and 1.57 tornadoes per year, respectively.

Based on the data for Chaves and Lea counties, as opposed to state-wide data used in the calculation presented earlier in this section, the average annual probability of a tornado occurring within any 1,000 square mile area in Chaves or Lea Counties can be approximated as:

$$\frac{0.73 + 1.57\ \mathit{tornadoes\ per\ year}}{6{,}070 + 4{,}392\ \mathit{sq\ mi}} = \frac{2.30\ \mathit{tornadoes\ per\ year}}{10{,}462\ \mathit{sq\ mi}} = \frac{0.22\ \mathit{tornadoes\ per\ year}}{1{,}000\ \mathit{sq\ mi}}$$

Table 10-7. Number of tornadoes (1950 – 2006) by location and F-Scale intensity (10-001).

New Mexico Location	Area Coverage (square miles)	Number of Tornadoes (1950 – 2006) by F-Scale Intensity[a]						Annual Probability of Occurrence Tornadoes per Year[b]					
		F0	F1	F2	F3	F4	Total	F0	F1	F2	F3	F4	Total
Statewide	121,355	341	108	32	4	-	485	6.09	1.93	0.57	0.07	-	8.66
Eight Southeast Counties	32,277	206	65	18	1	-	290	3.68	1.16	0.32	0.02	-	5.18
Individual Counties:													
Chaves County	6,070	31	8	2	-	-	41	0.55	0.14	0.04	-	-	0.73
Curry County	1,405	31	10	2	-	-	43	0.55	0.18	0.04	-	-	0.77
De Baca County	2,324	5	3	-	-	-	8	0.09	0.05	-	-	-	0.14
Eddy County	4,182	41	6	3	-	-	50	0.73	0.11	0.05	-	-	0.89
Lea County	4,392	60	20	7	1	-	88	1.07	0.36	0.13	0.02	-	1.57
Lincoln County	4,830	3	6	-	-	-	9	0.05	0.11	-	-	-	0.16
Otero County	6,626	6	4	1	-	-	11	0.11	0.07	0.02	-	-	0.20
Roosevelt County	2,448	29	8	3	-	-	40	0.52	0.14	0.05	-	-	0.71

a. Tornadoes reported within the past 57 years (1950 – 2006) (10-001).
b. Annual probability determined as the "Number of Tornadoes (1950 – 2006)" / 57 years.

The NCDC Storm Event Database was queried for tornadoes that have occurred near the Roswell site within the past 5 years. The query parameters used were:

- State = New Mexico,
- Start Date = November 1, 2001,
- End Date = October 31, 2006,
- County = Chaves and Lea, and
- Event Type = Tornado.

Results from this query are presented in Table 10-8. In order to identify all F2 or stronger tornados that have occurred within 1,000 square miles of the Roswell site over the past 5 years, a circular area centered on the facility and having a radius of 18 miles was defined. While the time period requirement was a selectable item in the query, the specific spatial requirement was not. Instead, the query was set to return information for all counties that fall within the 18-mile radius circular area. The locations of tornadoes returned in the query are displayed in Figure 10-3 where it is shown that no F2 or stronger tornadoes were reported within the surrounding counties and that no tornadoes of any intensity were reported within the 1,000-square mile area centered at the Roswell site in the last 5 years.

Table 10-8. Tornadoes reported in the past 5 years (November 2001 to October 2006) in Chaves and Lea Counties, New Mexico (10-001).

NM County	Tornado ID	Date	Intensity	Starting Lat / Long	Ending Lat / Long	Path Length (miles)
Chaves	1 – Mesa	9/13/2002	F0	33°59’/ 104°40’	33°59’ / 104°40’	0
Chaves	2 – Roswell	4/8/2004	F0	33°08’/ 104°49’	33°08’ / 104°49’	1
Chaves	3 – Roswell	4/8/2004	F0	33°11’/ 104°46’	33°11’ / 104°46’	1
Chaves	4 – Roswell	4/8/2004	F0	33°14’/ 104°41’	33°14’ / 104°41’	1
Chaves	5 – Roswell	4/8/2004	F1	33°16’/ 104°40’	33°14’ / 104°31’	1
Chaves	6 – Roswell	4/8/2004	F0	33°14’/ 104°31’	33°14’ / 104°31’	1
Chaves	7 – Dexter	4/8/2004	F0	33°15’/ 104°26’	33°15’ / 104°26’	0
Chaves	8 – Roswell	10/5/2004	F0	33°23’/ 104°36’	33°23’ / 104°36’	0
Chaves	9 – Hagerman	5/30/2005	F0	33°01’/ 104°13’	33°01’ / 104°13’	0
Chaves	10 – Roswell	8/14/2006	F0	33°10’/ 104°31’	33°10’ / 104°31’	0
Lea	<None>	-	-	-	-	-

(1) Tornadoes reported within the past 5 years (Nov 2001 – Oct 2006) (10-001).

10.5 Air Quality

The CAA, which was last amended in 1990, requires the EPA to set NAAQS for pollutants considered harmful to public health and the environment (10-014).

10.5.1 Air Quality Standards

The EPA Office of Air Quality Planning and Standards (OAQPS) has set NAAQS for six principal pollutants which are called “criteria pollutants” (see Table 10-9). Units of measure for the standards are presented as either parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), or micrograms per cubic meter of air ($\mu g/m^3$). The NAAQS are maximum concentrations measured in terms of local concentration of a pollutant in the atmosphere above which adverse effects on human health may occur.

There are two types of standards: primary and secondary. Primary standards were established to protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly. Secondary standards were established to protect public welfare, including protection against decreased visibility, and damage to animals, vegetation, and buildings.

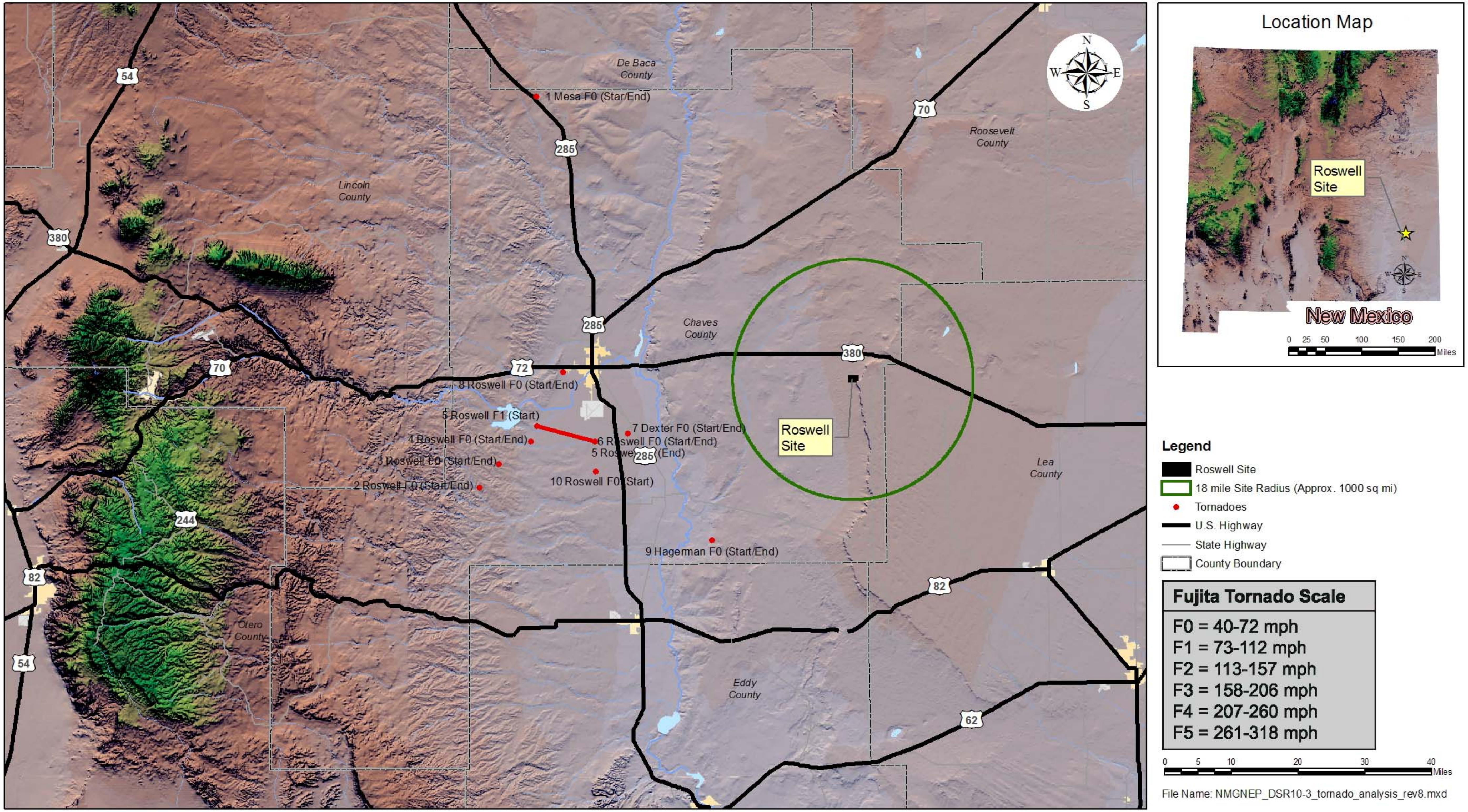

Figure 10-3. Tornadoes reported in the past 5 years in Chaves and Lea counties, New Mexico (10-018, 10-022).

Table 10-9. National Ambient Air Quality Standards (NAAQS) (10-014).

Criteria Pollutant	Averaging Time	Standard Value	Standard Type
Carbon Monoxide (CO)	8-hour	9 ppm (10 mg/m^3)	Primary
	1-hour	35 ppm (40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)	Annual (arithmetic mean)	0.053 ppm (100 µg/m^3)	Primary & Secondary
Lead (Pb)	Quarterly Average	1.5 µg/m^3	Primary & Secondary
Ozone (O_3)	8-hour	0.08 ppm	Primary & Secondary
	1-hour (applies in limited areas)	0.12 ppm	Primary & Secondary
Particulate Matter (PM_{10})	Annual (arithmetic mean)	Revoked	-
	24-hour	150 µg/m^3	Primary & Secondary
Particulate Matter ($PM_{2.5}$)	Annual (arithmetic mean)	15 µg/m^3	Primary & Secondary
	24-hour	35 µg/m^3	Primary & Secondary
Sulfur Dioxide (SO_2)	Annual (arithmetic mean)	0.030 ppm (80 µg/m^3)	Primary
	24-hour	0.14 ppm (365 µg/m^3)	Primary
	3-hour	0.50 ppm (1,300 µg/m^3)	Secondary

PM_{10} = particulate matter less than or equal to 10 microns in diameter.
$PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter.
mg/m^3 = milligrams per cubic meter of air
ppm = parts per million
µg/m^3 = micrograms per cubic meter of air

10.5.1.1 The New Mexico Environment Department and Ambient Air Monitoring Data

When the CAA was originally developed, the criteria pollutants were identified and air quality standards were established for these pollutants. Under the CAA, individual states were required to develop a State Implementation Plan (SIP) to define the strategy for assessing, and maintaining these established air quality standards. There are many different sources of the criteria air pollutants that contribute to a region's air quality. These include man-made emissions from industrial sources, mobile sources, land clearing, and residential sources, as well as natural sources (e.g., trees). Since all these sources must be considered in an assessment of air quality, the EPA has identified ambient air monitoring as the proper method for assessment.

As part of its SIP, the NMED Air Quality Bureau maintains an ambient air monitoring network within the state of New Mexico, excluding the tribal lands and Bernalillo County. This network includes 34 separate monitoring sites across the State, with each monitoring one or more of the criteria pollutants. There are 13 ozone monitors, nine nitrogen dioxide monitors, eight sulfur dioxide monitors, three carbon monoxide monitors, and 35 particulate monitors. The particulate monitors are for both PM_{10} and $PM_{2.5}$ (10-015).

The data collected from these monitoring sites are used primarily to define the nature and level of pollution in the State of New Mexico, determine which areas are meeting the air quality standards, and identify pollution trends in the state. The NMED Air Quality Bureau monitoring network measures the levels for five of the six criteria pollutants:

- Particulate Matter (PM_{10} and $PM_{2.5}$),
- Carbon monoxide,
- Nitrogen dioxide,
- Sulfur dioxide, and
- Ozone.

Monitoring of airborne lead was discontinued in 1998 because monitored levels were consistently below detection limits. Lead is no longer considered a major health threat in most of the United States with the phase-out of leaded gasoline.

10.5.1.2 Current Air Quality Status: Attainment versus Non-attainment

The CAA also requires that the EPA assign a designation of each area of the United States regarding compliance with the NAAQS. The level of compliance or noncompliance is categorized by EPA as follows:

- Attainment – Currently meets NAAQS
- Maintenance – Currently meets NAAQS, but was previously out of compliance
- Non-attainment – Currently does not meet NAAQS.

Generally, non-attainment areas are required to submit SIPs documenting how compliance with the NAAQS will be achieved. The EPA, however, is providing the option to states to prepare and submit an Early Action Implementation Plan and thus be granted a reclassification deferral by a certain deadline dependent on the type of pollutant, by which date, the standard will be attained or the area will be designated as non-attainment.

States continuously work towards achieving attainment with state and federal air quality standards for several reasons:

- Achieving compliance helps protect public health,
- Compliance contributes to economic growth,
- Non-attainment status can potentially limit production capabilities of existing industries and limit the installation of new industrial facilities,
- Attaining the air quality standards also helps to avoid the potential loss of federal highway funding that can result from non-attainment status, and
- Developing and implementing plans to retain attainment can be time-consuming and costly.

10.5.2 Non-Attainment Areas

There are currently three areas in New Mexico designated as either non-attainment or maintenance (10-016). These are listed and described in Table 10-10 and are shown on Figure 10-4.

Table 10-10. New Mexico non-attainment areas (10-016).

Area	Area Boundaries	Pollutant	Area Designation/Redesignation
Sunland Park	The non-attainment area is bounded by the New Mexico-Texas State line on the east, the New Mexico- Mexico international line on the south, the Range 3E-Range 2E line on the west, and the N3200 latitude line on the north.	O_3	Marginal non-attainment
Anthony	The non-attainment area is bounded by Anthony Quadrangle, Anthony, New Mexico - Texas. SE/4 La Mesa 15' Quadrangle, N32 00 - W106 30/7.5, Township 26S, Range 3E, Sections 35 and 36 as limited by the New Mexico/Texas State line on the south.	PM_{10}	Non-attainment
Phelps Dodge Smelter in Grant County	The maintenance area is defined as a 3.5-mile (5.6 km) radius region around the smelter. The maintenance area also includes high elevation areas within an 8-mile (13 km) radius.	SO_2	Maintenance – The state submitted a SIP to the regional EPA headquarters in August 1978. The Bureau submitted a redesignation plan to the EPA in February of 2003. The redesignation plan was approved by EPA in September 2003.

In addition, to these three areas listed in the table above there are three other areas that currently meet the air quality standards by a slim margin. These so called near non-attainment areas are Dona Ana County for PM_{10} and San Juan County for 8-hour ozone (see Figure 10-4). All other areas in New Mexico are classified as attainment for all criteria pollutants.

10.5.2.1 Non-Attainment Areas within the 50-mile Buffer of the Roswell Site

There are no non-attainment, maintenance, or near non-attainment areas within the 50-mile buffer radius of the Roswell site. The nearest non-attainment area (Anthony) is approximately 180 miles from the Roswell site.

Since the 50-mile radius around the Roswell site includes a small portion of Cochran and Yoakum counties in Texas, the non-attainment status of the surrounding areas in Texas was also reviewed. Based on a recent review of the Texas Commission on Environmental Quality non-attainment website information (10-017), there are no non-attainment, maintenance, or near non-attainment areas within the 50-mile radius of the Roswell site. The nearest non-attainment area in Texas is the El Paso area for CO and PM_{10}, which is approximately 200 miles from the Roswell site.

10.5.2.2 Natural Events Action Plan in Chaves County

In 2003, the 24-hour standard PM_{10} concentration of 150 micrograms per cubic meter was exceeded once in Chaves County at Roswell, which is approximately 40 miles from the Roswell site. This was due to prevailing strong winds from the south that occur primarily in late winter and spring, which can result in blowing and lifting dust into the air from areas of exposed soil. Since this exceedance was caused by natural events, EPA allows States to describe alternative steps and measures to take to avoid non-attainment status by developing a Natural Events Action Plan (NEAP) to protect public health. In October 2004, the NMED submitted to EPA a NEAP for Chaves County to avoid non-attainment (10-017).

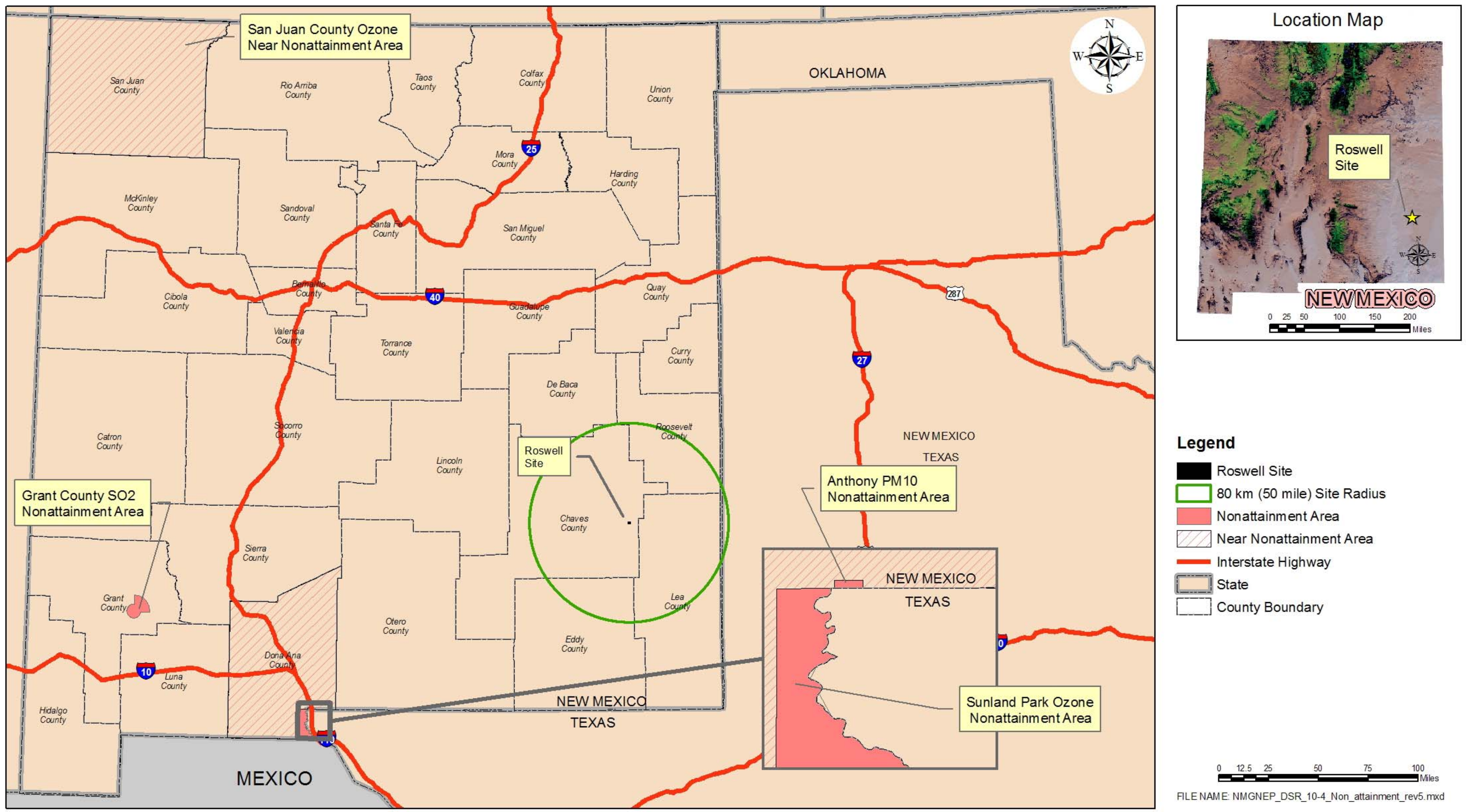

Figure 10-4. New Mexico non-attainment areas (10-026, 10-027, 10-028).

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CONTENTS

FIGURES

TABLES

11. HYDROLOGY / FLOODING

This section describes surface water hydrology and the potential for flooding at the Roswell site. The site is in a semi-arid to arid, upland area where flooding is unlikely. The basis for this conclusion is provided in the remainder of this section. An overview of the surface water hydrology and flooding assessment is provided in Section 11.1, and the maximum probable flood (MPF) is described in Section 11.2. The source of the MPF is described in Section 11.3, and the effects of current or planned activities on potential flooding is discussed in Section 11.4.

11.1 Overview and Summary

The Roswell GNEP site is located in arid high desert ranchland approximately 1 mile west of Mescalero Ridge. The escarpment at Mescalero Ridge was formed by erosion of the Ogallala formation and represents the most significant geographic feature in the vicinity of the Roswell site. The site was studied extensively to support preparation of a RCRA Part B Permit Application (11-005); Attachment L Section 2.1.4 of that permit application provides a concise overview of surface water hydrology:

> *The proposed site is located on the far eastern flank of the Pecos River Basin. The land surface gently slopes to the west at approximately 40 to 50 feet per mile toward the river. The sloping plain is characterized by low relief hummocky wind-blown deposits, sand ridges, and dunes. The Caprock escarpment (or Mescalero Rim) is one of the most prominent topographic features in southeastern New Mexico. East of the proposed site, the escarpment has approximately 200 feet of relief. Up gradient sources of surface water flow are bounded by the Caprock escarpment. The USGS Topographic Maps (7.5 minute series) for Mescalero* (11-006) *and Mescaleo N.E. … illustrate the topographic features and contributing surface water drainage areas pertinent to the site.*

The information presented below defines the site MPF, addresses the potential sources for a MPF at the Roswell site location, and provides detailed data and information that can be used to model the MPF. The evaluation of existing flooding information includes identification of resources that may be used to perform additional flooding studies once facility-specific conceptual designs are available.

A review of the most current information based on readily available and existing literature, supplemented by a site survey, lead to the following conclusions.

- No perennial surface water bodies are on or near the site. The nearest significant surface water body, the Pecos River, is about 35 miles west of the site.
- The site is not in or near a 10, 100, or 500 year floodplain delineated by Federal Emergency Management Act (FEMA). The closest such floodplain is along the Pecos River near Hagerman, New Mexico, about 35 miles from the site.
- The site is not subject to flooding of rivers or due to failure of upstream dams.
- The site is subject to ephemeral runoff following local rainstorms and during snowmelt.
- The only credible source of flooding is runoff from precipitation in the local watershed at and upstream of the site.

- Flooding due to runoff from local precipitation is limited by the small area (< 1 square mile) of the watershed upstream of the site.

- The data presented in this section do not indicate the presence of severe environmental consequences associated with hydrology / flooding for the construction and operation of GNEP facilities at this site.

11.2 Maximum Probable Flood and Sources

The factors that contribute to a MPF are the characteristics of a drainage basin and the greatest amount of precipitation that is reasonably possible in a given area. Historical meteorological data for the Roswell site are summarized in Section 10, Weather/Climatology. The sections below provide the definition of MPF and summarize the likely source for a MPF at the Roswell site.

11.2.1 Definition of the Maximum Probable Flood

The AMS defines "maximum probable flood" and "probable maximum flood" as "the flood that can be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a region" (11-021). No return frequency or recurrence interval is specified, nor are the parameters describing the flood event, e.g. floodwater elevations or flows.

11.2.2 Existing Site-Specific Runoff/Flood Studies

FEMA, through its National Flood Insurance Program (NFIP), is a primary source of flooding evaluations for over 20,000 communities nationwide. While FEMA reports identify other studies conducted in the region, none has addressed the specific area in and around the Roswell site. The Triassic Park RCRA Part B Permit Application (11-005) includes the only known evaluation of flooding at the Roswell site. The sections below discuss information available from FEMA and summarize flood evaluations from other sources.

11.2.2.1 Flood Plain Delineated by FEMA

The "Flood Insurance Study for Chaves County, New Mexico, Unincorporated Areas" (11-001) prepared by FEMA investigated the existence and severity of flood hazards in the unincorporated areas of Chaves County, New Mexico. The study was originally completed in March 1981 and was revised in 2003 to include new flood plain data for the Rio Hondo near Roswell. The study produced two maps, published separately: a Flood Insurance Rate Map (FIRM) for Chaves County (11-004) and a Flood Boundary and Floodway Map (11-012).

The report states that flooding generally results from overflow of the Pecos River and its principal tributaries, the Rio Hondo and the Rio Felix. Shallow flooding occurs in several smaller tributaries of the Pecos River including Thirteen Mile Draw, Tumbleweed Draw, and South Spring River. Flooding also occurs in three tributaries of the Rio Hondo including South Berrendo Creek, North Berrendo Creek, and North Spring River. These streams are shown on the FIRM (11-004) and the areas prone to flooding are shown on the Flood Boundary and Floodway Map (11-012). The NRCS TR-20 model (11-002) was used to determine peak discharge-frequency relationships for floods in these streams, with return periods of 10, 50, 100, and 500 years. Historical water flow measurements were evaluated statistically and used to calibrate the TR-20 model. For ungaged smaller streams including Thirteen Mile Draw, Tumbleweed Draw, and South Spring River, USGS regional equations were used to determine peak discharge-freqency relationships. Water surface elevations were then determined for the peak floods using aerial photogrammetry to establish channel profiles, and the ACOE Hydrologic Engineering Center software program HEC-2 (11-003) to determine flood profiles along each stream.

The Roswell site is not within any of the 10, 50, 100 or 500-year flood plains delineated in the FEMA study. The nearest is the Pecos River near Hagerman, approximately 33 miles west of the west perimeter of the study site, shown in Panel 752 of the Floodway Boundary and Floodway Map (11-012).

The FEMA FIRM Index for Chaves County Unincorporated Areas (11-004) identifies the Roswell site as lying within Flood Insurance Rate Zone 3501250850 B. The designation "B" describes "… flood insurance rate zones that correspond to areas outside the 1-percent annual chance flood plain, areas of 1-percent annual chance of sheet flow flooding where average depths are less than 1 foot, areas of 1-percent annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1-percent annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in these zones" (11-012). Section 3501250850 is identified as "Panel not printed. Area of minimal flood hazards" on the FEMA Flood Boundary and Floodway Map Index for Chaves County Unincorporated Areas (11-012).

11.2.2.2 Other Studies

Previous flooding studies are listed in Section 6.0 of the FEMA Flood Insurance Study (11-001). None of the studies cited evaluated the Roswell site, based on the summary description in the FEMA report. The FEMA study concludes the evaluation of previous studies by stating that "The present Chaves County flood insurance study is authoritative for purposes of the flood insurance program. Information presented here on the associated FIRM supersedes any existing flood hazard boundary maps for Chaves County."

The Roswell site was evaluated for flooding potential by Gandy Marley, Inc. (11-005) for a RCRA hazardous waste disposal facilit, that was proposed and permitted, but not built, for the 480 acres that comprise the western portion of the Roswell site. A RCRA Part B permit was issued by NMED but the facility has not been built. The nearest drainage to the site was determined from the USGS 7.5-minute series topographic map of the Mescalero Point Quadrangle (11-006) to flow westerly from Mescalero Point, and is approximately three-quarters of a mile south of the Roswell site. Rainfall run-off calculations were performed using the Rational Method to determine whether or not the Roswell site falls within the flood plain of a 100-year, 24-hour storm (11-013). The authors concluded that a flood plain does not exist for the drainage area, that there are no flood plains within 1 mile of the site, and that flood plain regulations are not applicable to the then planned Gandy Marley, Inc. facility.

11.2.2.3 Summary

The Roswell site is over 30 miles from the nearest 100-year flood plain identified in the FEMA flood study, and remote from any perennial surface water feature. Run-on to the site from perennial streams does not occur. Flooding from perennial surface water will not occur at the Roswell site, and only flooding from local precipitation events is possible. Existing studies do not define the MPF flows or elevations for the study area.

11.2.3 Determining the Maximum Probable Flood Using the TR-55 Method

Application of *Urban Hydrology for Small Watersheds* Technical Release 55 (TR-55) (11-007) for determining flooding resulting from local precipitation events on the Roswell site is discussed below. Applicability and limitations, data requirements and model implementation are discussed.

11.2.3.1 TR-55 Method Applicability and Limitations

TR-55 was designed primarily to evaluate the effects of urbanization on small watersheds. The NRCS defines small watersheds as "…the land surface draining to a definable point on a stream channel, where the area is less than 10 square miles (11-009). The TR-55 method was selected because this definition is appropriate for the scale of the Roswell site. TR-55 meets minimum flooding analysis requirements established by FEMA for the NFIP (11-008).

General limitations of the use of TR-55 (11-007) are listed below:

- Maximum area suitable for analysis is 25 square miles; no minimum is specified; however, "The user should carefully examine results from sub-areas less than 1 acre."
- The model is limited to 1-10 watershed areas.
- The methods used are based on open channel and/or unconfined overland flow; more information is required to account for flow in sewers.
- Both a Graphical Peak Discharge and a Tabular Hydrograph method are provided, however the graphical method is only appropriate for a single watershed subarea. Watersheds with multiple subareas can be modeled using the Tabular Hydrograph method.
- The model uses TR-20 (11-002) for all hydrograph procedures and produces a flood hydrograph (i.e., volumetric flow rate vs. time). Determining flood elevations requires use of a different model (e.g., HEC-2 [11-003]).

11.2.3.2 Data Requirements

The Roswell site is comprised of multiple drainage subareas, as identified in the field survey (11-015) and as shown on Figure 11-1, and therefore the TR-55 Tabular Hydrograph Method is appropriate. Tabular Hydrograph Method data requirements identified in TR-55 (11-007) are discussed below and available data are provided and referenced.

Watershed Delineation and Characteristics

A field survey was performed to delineate the watershed area and subareas, drainage reaches, stream channel dimensions; and to describe types of vegetative cover and condition (11-016). Figure 11-1 shows the limits of the drainage subareas and soil groupings overlain on the Mescalero Point quadrangle (11-006) as determined during the surface hydrology field survey. Photos from the field survey are included in the field survey report (11-016).

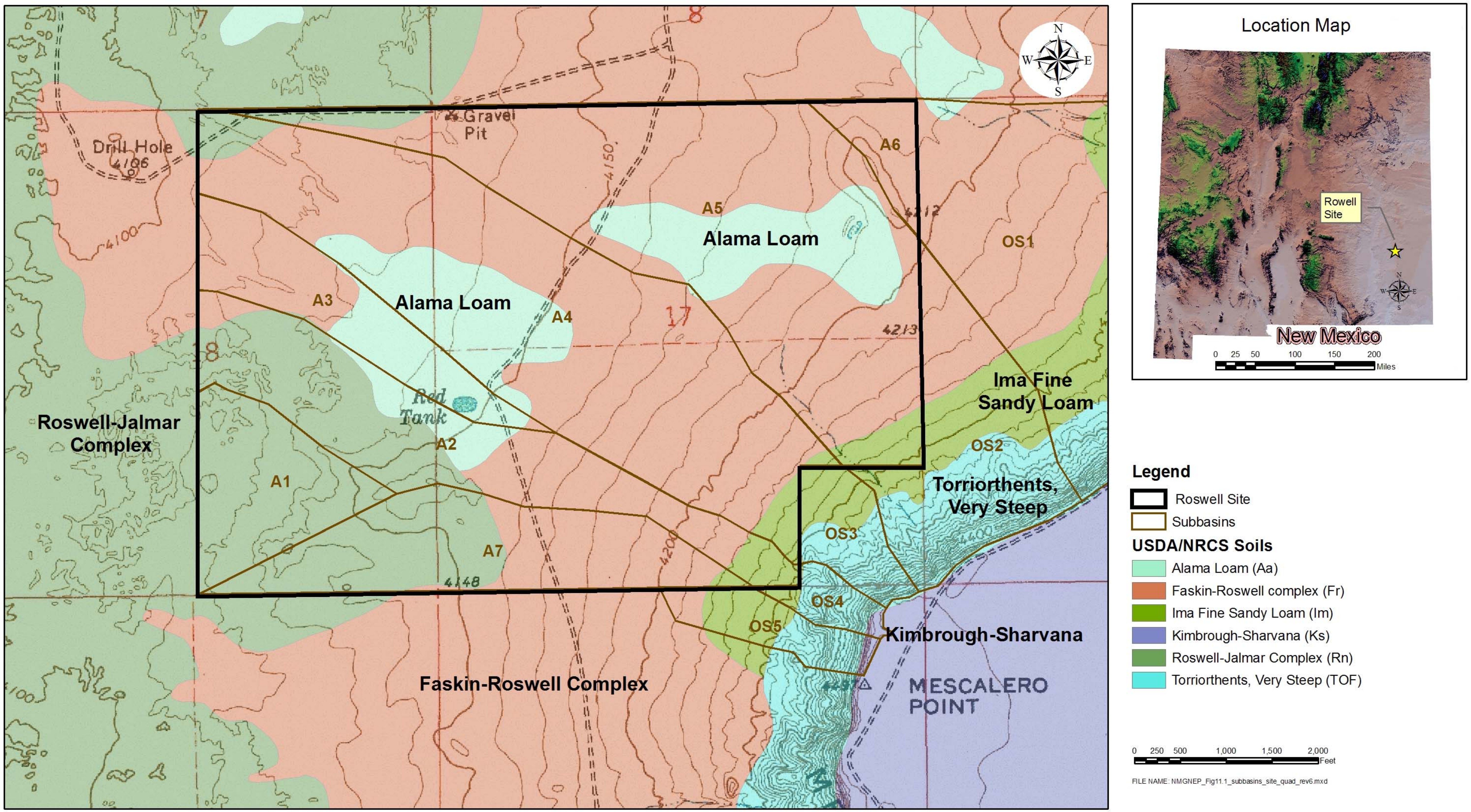

Figure 11-1. Drainage subareas and soil groupings identified for the Roswell site (11-022, 11-023).

Weighted Curve Number for Each Subarea

The model calculates a runoff curve number for each subarea. Calculating the runoff curve number requires the following data:

- Soil types for each subarea, typically from a map from a county soil survey showing areal extent of various soil types on/upstream of the Roswell site boundary. Figure 11-1 shows the soil units identified on the Roswell site (11-010). The area of each soil unit in each drainage subarea is listed below in Table 11-1. The hydrologic soil group for each soil unit in the study area is summarized in Table 11-2 (11-010).

- Vegetation or other cover types, treatment and condition for each subarea, estimated from the topographic map (11-006) or the site survey (11-016). Vegetative cover is generally described in the site survey as desert shrub, with soil ranging from fine sand to coarse gravel.

- Antecedent Runoff Condition, which accounts for storm-to-storm variations in runoff at a given site. Runoff curve numbers used in TR-55 assume average Antecedent Runoff Condition.

- Rainfall distribution, which is generated synthetically by the TR-55 program depending on geographic region. All of New Mexico including the Roswell site lies in a Type II distribution, based on Figure B-2 of TR-55 (11-007).

- Storm intensity, duration, and frequency for the site location. For example, 24-hour rainfall for a return frequency of 100 years is 5.76 inches, with a 90 percent confidence interval of 4.97 inches to 6.40 inches (11-011) for the Roswell site location centroid (Latitude 33°22'3.8" north, Longitude 103°51'5.1" west; or equivalently, 33.368° north, 103.851° west). Precipitation estimates in inches are given for storm recurrence intervals ranging from one to 1,000 years and storm durations ranging from 5 minutes to 60 days.

Table 11-1. Soil units and drainage areas determined in the Roswell site survey.

Drainage Subarea	Soil Unit Area (acres)						Total Acres
	Fr	Aa	Rn	Im	TOF	Ks	
A1	0	0	61	0	0	0	61
A2	42	19	59	7	0	0	127
A3	35	27	0.4	0	0	0	62.4
A4	211	51	8	8	0	0	278
A5	201	57	9	9	0	0	276
A6	20	0	0	0	0	0	20
A7	42	0	53	1	0	0	96
OS1	102	2	0	91	111	5	311
OS2	19	0	0	28	46	0	93
OS3	0	0	0	11	16	0	27
OS4	0	0	0	2	10	1	13
OS5	4	0	0	11	10	1	26

Table 11-2. Correlation of soil units at Roswell site to TR-55 hydrologic soil group (11-010).

Map Unit Symbol	Map Unit Name	Hydrologic Soil Group (HSG)	Soil Texture
Aa	Alama loam	B	Loam
Fr	Faskin-Roswell complex	The complex is not listed; Faskin and Roswell soil units are listed separately as HSG B and A, respectively	Faskin- sandy clay loam; Roswell-loamy fine sand
Im	Ima fine sandy loam	B	Fine sandy loam
Rn	Roswell-Jalmar complex	The complex is not listed; Roswell and Jalmar soil units are both listed separately as HSG A.	Roswell-loamy fine sand; Jalmar-fine sand
TOF	Torriorthents, very steep	Very steep is not listed; moderately steep is listed as D	Gravelly loam
Ks	Kimbrough-Sharvana complex	The complex is not listed; Kimbrough and Sharvana soils units are listed separately as HSG D and C, respectively	Kimbrough-gravelly fine sandy loam; Sharvana-fine sandy loam

Travel Time/Time of Concentration for Each Subarea

Time of concentration is the time required for water to flow from the farthest point in the watershed to the outlet. Data required to calculate time of concentration include:

- Slopes of subareas and reaches and slope lengths. Slopes of subareas are generally 1 to 2 percent. Drainage channels observed in the field survey begin and end within the study area, with the exception of:
    - The channels shown in field survey photos P2270006, P2270007 and P227008 (11-016). These channels are visible on the Mescalero Point quadrangle (11-006) and on Figure 11-1. These channels begin on the study area and exit the west perimeter in drainage subareas A3 and A4. Each of the two channels that exit the west perimeter is on the order of 2,000 feet long with a vertical drop of approximately 30 feet.
    - The channel shown in field survey photos P227023, P227024, P227026 and P227027 that enters the southeast corner of the property and terminates within approximately 2,000 feet. This channel appears on the Mescalero Point quadrangle as an emphemeral stream.
    - Other smaller channels observed in the field survey in the southeast corner of the property that do not appear on the Mescalero Point quadrangle.
- Channel shape and surface description. These are also shown in the photo log and field report (11-016).

- Each of the two channels that exit the west perimeter are roughly trapezoidal in cross section, with roughly 3h:1v sideslopes; and are on the order of 5 to 7 feet wide at the top and 2 feet deep where they exit the west perimeter. The channel surfaces are fine sand with sparse brush.

- The channel that enters the southeast corner of the property is roughly rectangular in cross section with near-vertical sides; and is on the order of 4 to 10 feet wide at the top and 3 to 6 feet deep. The channel surface is coarse gravel with occasional boulders and sparse brush.

• Manning's roughness coefficient (*n*). Methods for calculating and/or lookup values for Manning's *n* are readily available (11-014, 11-015).

Implementing the Model for the Roswell Site

The validity of the TR-55 model output will depend in part on how the model drainage areas, subareas and channel reaches are identified and parameterized. Several field survey observations are important to note:

• No continuous channels are present that extend the length of the Roswell site or of drainage subareas;

• None of the visible channels appear to drain to a common outlet; and

• High infiltration rates of surface drainage into soil are apparent, as evidenced by visible drainage channels fanning out and disappearing (Photo P228044 [11-016]). Concentrated flows appear to dissipate in short distances relative to the size of the Roswell site and drainage subareas.

11.3 Sources for the Maximum Probable Flood

The Roswell site is remote from streams and rivers that could be sources of flooding, and the site is far from identified flood plains (Section 11.2). The river closest to the Roswell site, the Pecos River, is approximately 35 miles away. Although flooding occurs along the Pecos River and FEMA has identified floodplains along the river and its tributaries, the site is remote from areas affected by flooding along rivers and streams. The only likely flood source is runoff from precipitation at the site and in the watershed upstream of the site (Section 11.3). The watershed extends only as far as the crest of Mescalero Ridge, and the small area (<1 square mile) of the watershed upstream of the Roswell site will limit flood flows.

11.4 Effect of Current or Planned Activities on Maximum Probable Flood

Based on review of available information and the results of the surface water hydrology field survey, it is not anticipated that any current or planned activities in the watershed other than construction of the Roswell site facilities will affect the MPF. Several existing small check dams blocking drainage channels were observed in the field survey; however, these would likely have no effect on the MPF. Once conceptual facility design information is available, including an estimate of the portion of the watershed that will be covered by impermeable surfaces, the effects of site development on the MPF may be determined using TR-55 calculations.

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CONTENTS

TABLES

12. REGULATORY AND PERMITTING

This section identifies major requirements that could be applicable to the construction or operation of GNEP facilities at the Roswell site. The section discusses federal, state, and local provisions, identifies specific permitting requirements, and describes potentially applicable requirements that may not include site-specific permits or approvals.

12.1 Overview and Summary

National, state and regional regulatory and environmental requirements were reviewed and analyzed to identify permits, approvals, and procedures that could impose requirements on GNEP facilities developed and operated at the Roswell site, and to pinpoint any requirements that might impose barriers to siting such facilities.

- No legislative or regulatory prohibitions that might prevent siting GNEP facilities at Roswell were identified, and no processes that contained requirements capable of barring such facilities were found.
- The body of data developed in the overall site study uniformly indicate that needed permits and approvals will be obtainable.
- Site data indicate that federal requirements for historic, tribal, and cultural resource protection can be met.
- Because of factors unique to the site, for example that it sits over 30 miles from the nearest waters of the United States, some permits, such as an section 404 permit, are not likely to be required.

Table 12-1 provides a detailed cross-walk between the body of applicable federal (Sections 12.2 and 12.3), state (Section 12.4), and local (Section 12.5) regulations or permitting requirements. A conservative approach was taken in reviewing the regulatory and permitting requirements. Because the facility design has not been finalized, the specific applicability of certain requirements could not be determined. In such cases, the various permitting scenarios are identified, as well as the conditions under which each type of permit would apply.

Table 12-1. Summary of regulatory and permitting requirements for the Roswell site.

Activity/Program	Action or Requirement	Statute or Regulation	Agency(ies)
Section 12.2	**Atomic Energy Act Requirements**		
Advanced Nuclear Reactor Licensing (Section 12.2.1)	Domestic licensing of production and utilization facilities	10 CFR 50	NRC
	Early Site Permit (ESP) (site safety analysis, environmental report, emergency planning information)	10 CFR 52	NRC
	Standardized Design Certifications	10 CFR 52	NRC
	Combined licenses for nuclear power plants	10 CFR 50 10 CFR 52	NRC
Nuclear Fuel Recycling Center Licensing: Fuel Treatment Facility (Section 12.2.4.1)	Domestic licensing of production and utilization facilities	10 CFR 50	NRC
Nuclear Fuel Recycling Center Licensing: Fuel Fabrication Facility (Section 12.2.4.2)	Domestic licensing of special nuclear material	10 CFR 70	NRC
	Environmental Review	10 CFR 51	NRC
Section 12.3	**Other Federal Programs and Requirements**		
Air Emissions (Section 12.3.1)	Compliance with National Primary and Secondary Ambient Air Quality Standards	40 CFR 40	EPA
	New Source Performance Standards (NSPS)	40 CFR 60	EPA
	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 61	EPA
	New Source Review (NSR)	40 CFR 51	EPA (actual permits issued by NMED)
	Radioactive emissions	10 CFR 20	NRC

Table 12-1. (continued).

Activity/Program	Action or Requirement	Statute or Regulation	Agency(ies)
Wastewater and Storm Water Discharges (Section 12.3.2)	National Pollutant Discharge Elimination System (NPDES) Permit	40 CFR 122 40 CFR 123 40 CFR 124	EPA
	NPDES Stormwater Permit: Stormwater Pollution Prevention Plan, Construction General Permit	40 CFR 122 40 CFR 123	EPA
	Section 404 (Wetlands) Permit	33 CFR 320 - 330	USACE
Natural Resources (Section 12.3.3)	ESA Section 7 consultation	50 CFR 402.6	USFWS
Historical, Tribal and Cultural Resources (Section 12.3.4)	Notification for discovery of unanticipated archaeological materials (Archaeological and Historic Preservation Act [AHPA])	16 U.S.C. 469 – 469c	Department of the Interior
	Permit for excavation or removal of archaeological resources (Archaeological Resources Protection Act [ARPA])	16 U.S.C. 470aa et seq.	Department of the Interior; affected Native American Tribes
	Permit to Proceed (Antiquities Act)	16 U.S.C. 431 36 CFR 296 43 CFR 3 and 7	Department of the Interior
	American Indian Religious Freedom Act (AIRFA)	42 U.S.C. 1996	Various Federal agencies
	Native American Graves Protection and Repatriation Act (NAGPRA)	25 U.S.C. 3001	Department of the Interior
	Consultation and coordination with Indian tribal governments	EO 13175	Department of the Interior
National Environmental Policy Act (NEPA) (Section 12.3.5)	EIS	42 USC 4321 et. seq.	Department of Energy (DOE), NRC, EPA
	Environmental protection regulations for NEPA implementation - licensing and related regulatory functions	10 CFR 1021 10 CFR 51	DOE, NRC
Federal Land Management (Section 12.3.6)	Federal Land Policy and Management Act of 1976 (FLPMA)	43 U.S.C. 1701 et seq.	BLM

Table 12-1. (continued).

Activity/Program	Action or Requirement	Statute or Regulation	Agency(ies)
Hazardous Materials Packaging and Transportation (Section 12.3.7)	Hazardous Materials Transportation Regulations	49 CFR 171-180 49 CFR 397	Department of Transportation (DOT)
	Radioactive Materials Packaging and Transportation Regulations	10 CFR 71 10 CFR 73	NRC
Hazardous Material Inventory and Toxic Release Reporting (Section 12.3.8)	Emergency Planning and Community Right-to-Know Act (EPCRA), Sections 311 and 312	42 U.S.C. 11001 et seq.	State Emergency Response Commission, Local Emergency Planning Committee, local fire department
	EPCRA, Section 313	42 U.S.C. 11001 et seq.	EPA, State Emergency Response Commission
Section 12.4	**State Programs and Requirements (including state implementation of federal requirements)**		
New Mexico Construction Permits and Approvals (Section 12.4.1)	Licensing for persons possessing, storing, procession or altering radioactive material.	§74-3-1 New Mexico Statutes Annotated (NMSA) 20.3.1 NMAC	NMED
	New Mexico Construction Industries Division Approval	14.5.2 NMAC	New Mexico Construction Industries Division
	Discharge permit (evaporation ponds, site storm water retention basins, and wastewater treatment or septic system)	20.6.2.3104 NMAC	NMED Ground Water Quality Bureau
New Mexico Air Quality Program (Section 12.4.2)	New Source Review (NSR) preconstruction permitting program	20.2.73.NMAC	NMED
	Construction Permit	20.2.72 NMAC	NMED
	Air operating permit	40 CFR 61 40 CFR 63 20.2.70.NMAC	NMED
Wastewater and Water Quality (Section 12.4.3)	Discharge permit	20.6.2.3104 NMAC	NMED
	Section 401 Certification Process	40 CFR 121	NMED

Table 12-1. (continued).

Activity/Program	Action or Requirement	Statute or Regulation	Agency(ies)
Drinking Water, drilling permit, and injection well (Section 12.4.4)	Drinking Water System Approval	40 CFR 141-149 40 CFR 142 40 CFR 143 20.7.10 NMAC	NMED
	Well drilling permit	72-12-1 NMSA	NM Office of the State Engineer
	Underground injection well permit	40 CFR Subpart D 20.6.2 NMAC	NMED
Solid and Hazardous Waste Management (Section 12.4.5)	Treatment, Storage, and Disposal Facility (TSDF) Permit modification	40 CFR 124 40 CFR 264 40 CFR 270 20.4.1 NMAC	NMED
	Hazardous waste facility siting criteria	40 CFR 264.18 40 CFR 270.14(b)(11)	NMED
	Hazardous Waste Generator standards	40 CFR 262; 20.4.1 NMAC	NMED
	Solid Waste Facility Permit	74-9-1 NMSA et seq. 20.9.1 NMAC et seq.	NMED
Historical, Tribal and Cultural Resources (Section 12.4.6)	NHPA Section 106 Consultation	36 CFR 800	SHPO, Advisory Council on Historic Preservation
Emergency Planning (Section 12.4.7)	State EPCRA implementation	New Mexico Hazardous Chemicals Information Act, §74-4E-1	New Mexico Emergency Response Commission
Hazardous Materials Packaging and Transportation (Section 12.4.8)	Designation of preferred transportation routes for radioactive materials	74-4A-1 NMSA	New Mexico State Transportation Commission
State Involvement in Licensing Radioactive Materials	New Mexico Radioactive and Hazardous Materials Act	NMSA 74-6-1 et. seq.	NMED

Table 12-1. (continued).

Activity/Program	Action or Requirement	Statute or Regulation	Agency(ies)
Section 12.5	**Local (County and Regional) Programs and Requirements**		
Special use permit or certificate of zoning (Section 12.5.1)	Chaves County Zoning Ordinance	Special Use Permit or Certificate of Zoning	Chaves County Commission
Building permit (Section 12.5.2)	Chaves County Building Permit Procedure	Chaves County Building Permit	Chaves County Building Inspector

12.2 Atomic Energy Act of 1954, as Amended

The Atomic Energy Act (AEA) of 1954 Public Law (PL) 83-703, as amended (12-001), governs civilian and military use of nuclear materials. The AEA requires licensing by the NRC for civilian use of nuclear materials. The AEA empowers the NRC to establish and enforce standards to protect health and safety at civilian nuclear facilities. This section describes the NRC licenses and certifications required for siting, design, construction, and operation of an advanced recycling reactor and a nuclear fuel recycling center at the Roswell site.

12.2.1 Nuclear Power Plant Licensing Processes

The NRC provides two processes for licensing reactors. These processes are codified in:

- 10 CFR 50, Domestic Licensing of Production and Utilization Facilities (12-003); and
- 10 CFR 52, ESP; Standardized Design Certifications; and Combined Licenses for Nuclear Power Plants (12-002).

The NRC follows a standard review plan, conducting a comprehensive evaluation of a facility's safety analysis reports for every nuclear power plant (12-092). Criteria, including facility siting, design and operation, are addressed during licensing review. However, the 10 CFR 52 licensing process allows facility location and design to be approved as initial steps, followed by approval of construction and operation.

The 10 CFR 50 and 10 CFR 52 permitting processes are interrelated to some extent. 10 CFR 52 early site permit applications are reviewed in part against 10 CFR 50 standards. A 10 CFR 52 combined license application must include information equivalent to that required for a 10 CFR 50 operating license.

The NRC has recognized that its regulations for licensing reactors reflect experience gained with light-water reactors (LWRs). While many provisions are generic or independent of reactor technology, others are specific to LWR design. Design considerations for an advanced reactor will be different (12-006). It will be important for the NRC to be engaged early in the process so that an appropriate technical and regulatory infrastructure for licensing can be established.

12.2.2 10 CFR 50 (Two-Step) Process

The 10 CFR 50 process is based on licensing LWR facilities and may not be preferred for licensing an advanced reactor, though all currently operating plants were licensed under this process. Part 50 regulations require submission of both a Safety Analysis Report and an analysis of potential environmental impacts. When an application is deemed sufficient, the NRC publishes a notice in the federal register and holds an initial public meeting near the site.

The NRC conducts a safety review and an environmental review and determines whether the plant design meets applicable regulations. The Advisory Committee on Reactor Safeguards (ACRS) also reviews the application, submitting results to the NRC. Staff then prepares a Safety Evaluation Report and conducts a NEPA review. The NRC may grant an at-risk Limited Work Authorization. An Atomic Safety and Licensing Board public hearing is conducted before a construction permit can be issued.

The applicant then submits an application for an operating license, accompanied by a Final Safety Analysis Report. The NRC publishes notice of the application, prepares a Final Safety Evaluation Report, receives advice from the ACRS, and may then issue an operating license.

12.2.3 10 CFR 52 (Early Site Permit, Standard Design Certification and Combined License) Process

The 10 CFR 52 process contains three major elements: 1) the ESP, 2) the standard design certification, and 3) the combined license (COL). An application may be sought for all three elements, or for a COL only, without referencing an ESP or a standard design certification. In the latter case, NRC would review the technical and environmental information in the manner described for the two-step licensing process.

12.2.3.1 Early Site Permit

An ESP is the first step in the licensing process under 10 CFR 52. The purpose of the ESP is to assess the safety and environmental characteristics of the Roswell site and evaluate whether an acceptable emergency plan can be developed. An applicant for an ESP must submit a site safety analysis, an environmental report, and emergency planning information. A generalized plant description with estimated maximum levels of radioactive and thermal effluents is also used to assess site suitability. The NRC documents its findings through a Safety Evaluation Report and in draft and final EISs.

An ESP is valid for no more that 20 years and can be renewed for 10 to 20 years. It allows limited site preparation work to be conducted prior to issuance of a construction license. The ESP typically undergoes a 21-month technical review period, followed by a 12-month period that ends in a Commission decision (12-099). Industry estimates are that the ESP approval process takes 2½ years (12-090). An ESP was issued to Exelon Generation Company for the Clinton Site near Clinton, Illinois on March 15, 2007. The permit process took 3½ years (12-091).

12.2.3.2 Design Certification

The NRC conducts an extensive review of a reactor plant design and provides approval of the design, independent of the particular location. Once a design is certified, a plant design can be ordered and licensed for the specific site. The certification process is formalized as a rulemaking with opportunities for public comment. The process includes review for safety concerns by the ACRS, an independent group that provides advice on reactor safety to the NRC. The process of design certification can last from 5 to 8 years (12-090). A design certification is effective for 15 years.

12.2.3.3 Combined License

The final step in licensing a nuclear reactor is a combined construction permit and operating license, referred to as a COL. The COL would reference the ESP and design certification, and issues resolved through the earlier proceedings are considered resolved for purposes of the COL application. The information required for an operating license application, pursuant to 10 CFR 50, must be provided. In addition, the inspections, tests, analyses, and acceptance criteria that will be used to assess the plant's compliance during construction and upon completion must be identified. The application is reviewed by the ACRS. The NRC will conduct a hearing before issuing a COL. The COL process could take up to 3 years (12-090). In addition to periodic inspections during construction, the NRC will assess the reactor's compliance with final acceptance criteria set out in the COL. The NRC must find that these criteria are satisfied before operation can commence.

12.2.4 Nuclear Fuel Recycling Center Licensing

A Fuel Recycling Center would involve two activities that NRC licenses: 1) reprocessing and 2) fuel fabrication. 10 CFR 50 has also provided a licensing process for fuel treatment facilities. 10 CFR 70, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, provides a licensing process applicable to a fuel fabrication facility. The requirements for licensing are addressed in this section.

12.2.4.1 Processing Facility

A processing facility is defined as a production facility that requires a license under the regulations in 10 CFR 50, Domestic Licensing of Production and Utilization Facilities. The current requirements are based upon a LWR design for licensing a facility. Some of these requirements would not apply, and the design of the reprocessing facility may introduce additional and different facility safety considerations. A case-by-case approach to licensing would be developed, or new rules would be established, to guide the licensing process. The NRC has indicated that the requirements of 10 CFR 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions and the agency's NEPA Procedures would also apply during licensing (12-068, 12-069). Environmental impacts related to transporting spent nuclear fuel to the reprocessing facility and product shipments from the facility would have to be evaluated.

12.2.4.2 Fuel Fabrication Facility

A fuel fabrication facility would be licensed under 10 CFR 70, Domestic Licensing of Special Nuclear Material. The NRC has prepared regulatory guidance specific to a fuel fabrication facility, NUREG-1520, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (12-070). Additional guidance or requirements may be needed to address issues such as specific feed stocks for the facility. An environmental review under 10 CFR 51 would also be required for facility impacts that include material storage and waste disposal.

12.3 Other Federal Regulatory Programs

The following subsections address major Federal laws and regulations likely to apply to construction and/or operation of the Roswell site.

12.3.1 Air Emissions

The CAA was first promulgated in 1963 as PL 88-206. It has been amended several times since that date, with the most significant amendments occurring as the result of the CAA of 1970 (PL 91-604) and the CAA Amendments of 1990 (PL 101-549). The purpose of the CAA is to establish standards for the control of air pollution (12-003).

12.3.1.1 National Ambient Air Quality Standards

The CAA requires EPA to establish NAAQS for pollutants considered harmful to public health and the environment. The CAA established two types of NAAQS. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings (12-073).

The EPA has established NAAQS for six principal pollutants which are called "criteria" pollutants: PM_{10} and $PM_{2.5}$, carbon monoxide, sulfur oxides, nitrogen oxides, ground-level ozone, and lead. The NAAQS represent the maximum allowable concentrations measured in terms of local concentration of a pollutant in the atmosphere (12-073).

12.3.1.2 New Source Performance Standards

EPA is required under Section 111 of the CAA to establish NSPS for each category of stationary sources that "causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare" (12-072). The NSPS program sets uniform emission limitations for industrial categories or sub-categories of sources and is intended to promote the use of best available air pollution control technologies. The NSPS are codified in 40 CFR 60. There are no NSPS that will apply to this project.

12.3.1.3 National Emission Standards for Hazardous Air Pollutants

Section 112 of the CAA requires EPA to regulate emissions of 187 Hazardous Air Pollutants (HAPs) from a published list of industrial source categories. For these source categories, EPA has developed industry-specific technology requirements to control HAP emissions. These standards are known as NESHAPs. EPA has developed eight NESHAPs that address emissions of radionuclides to the atmosphere. However, these NESHAPs are industry specific, and no NESHAP has been promulgated for emissions from a nuclear power or processing facility (12-078, 12-044). None of these existing standards will be applicable at the Roswell site.

12.3.1.4 Radioactive Emissions

Radionuclide air emissions from the proposed GNEP facility would be regulated by the NRC under 10 CFR 20 (12-043), which requires licensees to establish a dose constraint for air emissions of radionuclides. While New Mexico is an agreement state, the proposed GNEP facilities fall under the 10 CFR 150.15 declaration of persons not exempt from NRC regulation (12-080).

12.3.1.5 *New Source Review*

NSR (12-074) is a preconstruction permitting program established under the CAA to ensure that air quality is not significantly degraded through the addition of new sources of air pollution. The NSR program requires all stationary sources of air pollution to obtain a permit prior to starting construction.

There are three types of NSR permitting requirements depending on the size of the proposed facility and the attainment status of the area where the facility will be located. These are:

1. Prevention of Significant Deterioration (PSD), which includes permits for the construction of major sources of air pollutants or for facilities that are making a major modification to an existing source of air pollutants. For purposes of air permitting, a major source is defined as a source that has the potential to emit 100 tons per year or more of any regulated pollutant, 10 tons per year or more of any HAP, or 25 tons per year of any combination of HAPs. PSD permitting also includes the requirement to demonstrate compliance with the PSD increment through the use of air transport modeling. The PSD increment is the amount of pollution an area is allowed to increase while still maintaining compliance with the NAAQS.

2. Nonattainment NSR, which applies to the construction of new major sources or major modifications of existing sources in a nonattainment area.

3. Minor source permitting, which applies to new sources and modifications of existing sources that emit air pollutants below the major source threshold. Facilities that have the potential to emit above the major source threshold but that take operating limits to lower their potential to emit below the major source threshold can also qualify for this permitting option. These sources are referred to as synthetic minor sources.

The Roswell site is in attainment with ambient air quality standards. Therefore, option 2 does not apply to this site. The final design and operating conditions for the project will determine if the facility will be a major source, minor source, or synthetic minor source.

12.3.1.6 Air Emission Operating Permits

Operating permits for sources of air pollutants are issued by EPA and state agencies to whom EPA has delegated permitting authority. Permitting authority within the State of New Mexico has been delegated to NMED.

Permits for major sources are issued under 40 CFR 70 or corresponding state regulations, and are typically referred to as Title V operating permits in reference to Title V of the CAA (12-076). Operating permits for minor sources are issued in accordance with state regulations.

12.3.2 Wastewater and Storm Water Discharges

The CWA of 1977 establishes the basic structure for regulating pollution of surface waters of the United States (12-005). The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit is obtained under the Act’s provisions.

The CWA requires states to set water quality standards for all bodies of water within their boundaries and directs EPA and the states to regulate and issue permits for point-source discharges as part of the NPDES permitting program. Under the CWA, EPA has established a program whereby the EPA or individual states can issue permits for stormwater discharges related to industrial activity, including construction activities that could disturb 5 or more acres (40 CFR 122), (12-020). The CWA recognizes but does not regulate problems posed by nonpoint source pollution.

12.3.2.1 National Pollutant Discharge Elimination System

The NPDES permit program, established in Section 402 of the CWA, protects surface water quality by regulating point source discharges of pollutants to surface watercourses. As authorized by the CWA, the EPA NPDES permit program controls water pollution by regulating point sources that discharge pollutants into surface waters of the U.S.[1].

In New Mexico, the NPDES permit program is administered by EPA. An applicant may apply for either an individual or a general NPDES permit. An individual permit is specifically tailored to an individual facility, and a general permit covers multiple facilities with a specific category, such as storm water discharges (12-093).

Permits specify the control technology applicable to each pollutant, the effluent limitations a discharger must meet, and the deadline for compliance. The permit incorporates numerical effluent limitations issued by EPA. Permittees are required to maintain records and carry out effluent monitoring activities. Permits are issued for 5-year periods and must be renewed thereafter to allow continued discharge (12-094).

Industrial Wastewater

Wastewater is spent or used water that contains enough harmful material, such as oil, dirt, human waste, and chemicals, to damage the water's quality. Any structure or facility that generates wastewater must dispose of it through a wastewater treatment and disposal system (12-094). Some industries may discharge their wastewater directly to a sanitary sewer, where it is conveyed to a wastewater treatment plant. This wastewater may be subject to pretreatment requirements under the wastewater treatment plant's NPDES permit (12-086). Sites not served by public sewer systems depend on decentralized, on-site septic systems to treat and dispose of wastewater (12-094).

Industrial point sources of pollution that discharge wastewater directly to surface waters are required to obtain NPDES permits that limit the amount of pollution that may be discharged into surface waters (12-093). There are no lakes, streams or rivers near the proposed site (see Section 3, Water Resources). Consequently, it is unlikely that GNEP facilities operating at the Roswell site would discharge industrial effluents to offsite surface watercourses, and no NPDES permit for discharge of industrial effluents from the site would likely be needed.

Storm Water

The NPDES permit program includes an industrial stormwater permitting component adopted under Section 402 of the CWA. The NPDES General Permit for Industrial Stormwater regulates point source discharges of stormwater runoff from industrial and commercial facilities to waters of the United States. Since there are no waters of the U.S. within approximately 30 miles of the Roswell site, it is questionable whether construction of GNEP facilities at the site would require coverage under an NPDES Stormwater General Permit for either construction or operation. Design, construction and operational details of facility storm water systems and stormwater pollution prevention plans should, however, be provided to EPA and NMED for review and possible determination that a permit is needed, or that the facilities can be excluded from the stormwater permitting requirement on the basis that there is no exposure of waters to pollution.

[1] The NPDES permit program in New Mexico is administered by EPA. The State began the process of acquiring program permitting authority from EPA in 2004.

12.3.2.2 Permits for Dredged or Fill Material

Section 404 of the CWA gives the USACE permitting authority over activities that discharge dredge or fill material into waters of the U.S. The proposed site activities will not discharge dredge or fill into any such waters. If the construction or modification of rail lines or highways to the site included dredge or fill activities or other actions that would discharge dredge or fill into waters of the U.S., those activities would require Section 404 permits.

The USACE has the authority to make a jurisdictional determination as to the existence or absence of "waters of the United States" at the proposed GNEP site location. Jurisdiction can be based on a determination that there are waters of the U.S., navigable waters of the U.S., or non-navigable, intra-state waters or wetlands that could affect the water quality of navigable waters. A decision that a jurisdictional determination is not required would provide an analysis by the USACE as to whether waters of the U.S. could be affected by GNEP activities at the proposed site.

12.3.2.3 Floodplain Assessment

Floodplains are lands that are subject to periodic flooding. Often, they occur where annual water flow is low or non-existent, but they may also occur due to large amounts of melting snow or rainfall that run off the land. A 100-year floodplain is any land area that is subject to a 1 percent or greater chance of flooding in any given year from any source (12-096).

As discussed in Section 11, Hydrology/Flooding, the Roswell site is demonstrated to be above the 100-year flood plain. In addition, the site is remote from any perennial surface water feature. The Pecos River, approximately 35 miles from the site at its closest point, is the closest significant water body. Information needed to calculate potential flooding due to runoff in ephemeral drainages from local storms and snowmelt is contained in Section 11, Hydrology/Flooding. Flooding from perennial surface water will not occur at these sites.

12.3.3 Natural Resources Protection

There are three designations given to species under the ESA of 1973, as amended, which offer protection to plants and animals that have been found to warrant protective measures to ensure their survival and existence (12-007). These designations are that of endangered, threatened, or candidate species, which are further described in Section 5, Threatened or Endangered/Special Concern Species. An endangered species is an animal or plant species in danger of extinction throughout all or a significant portion of its range. A threatened species is an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range; and a candidate species is a plant or animal species for which USFWS or NMFS has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened.

A species of concern is an informal term used by USFWS and NMFS, as well as many state agencies, that refers to a species that might be in need of conservation action or is considered sensitive, rare, or declining on lists maintained by Natural Heritage Programs, state wildlife agencies, other Federal agencies, or professional/academic scientific societies. This may range from a need for periodic monitoring of populations and threats to the species and its habitat, to the necessity for listing as threatened or endangered. Such species receive no legal protection and use of the term does not necessarily imply that a species will eventually be proposed for listing.

12.3.3.1 Section 7 Consultation

The ESA is intended to provide a means to conserve the ecosystems upon which endangered and threatened species depend and provide programs for the conservation of those species, thus preventing extinction of plants and animals. The law is administered by USFWS and NMFS, depending on the species. Section 7 of the ESA requires all Federal agencies, in consultation with USFWS or NMFS, to use their authorities to further the purpose of the ESA and to ensure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.

The interagency cooperation requirements of Section 7(a)(2) of the ESA are to be carried out in consultation with the Secretary of the Interior, via the USFWS. The need to initiate consultation is usually determined by the governing federal agency, which in the case of the GNEP facilities is the DOE, and is based on an analysis to determine if an individual of a federally listed species, or its designated critical habitat, may be affected by a proposed action. The DOE must initiate consultation if a listed species is known, or suspected, to occur on land that will be affected by an action, and the DOE determines that individuals, populations, or designated critical habitat of threatened or endangered species may be affected by the action, either positively or negatively.

12.3.3.2 Biological Opinion

The consultation results in a biological opinion by USFWS or NMFS determining whether the proposed action would jeopardize the continued existence of the species under consideration, or result in destruction or adverse modification of critical habitat. If jeopardy is not found, but some individuals may be incidentally killed as a result of the proposed action, the services can determine that such losses are acceptable if specified measures are followed.

Two candidate species, the sand dune lizard and the lesser prairie-chicken are found in the vicinity of the site. Extensive biological survey of the site found no critical habitat for either species.

12.3.4 Historical, Tribal and Cultural Resources

This subsection addresses federal laws and regulatory programs for the preservation of historical, tribal, and cultural resources. Historical, archaeological, and cultural resources are further described in Section 7, Historical, Archaeological, and Cultural Resources.

12.3.4.1 National Historic Preservation Act

The NHPA was enacted to create a national historic preservation program, including the NRHP and the Advisory Council on Historic Preservation. The NHPA provides for the placement of sites with significant national historic value on the NRHP. It requires no permits or certifications.

12.3.4.2 Archaeological and Historic Preservation Act

The AHPA of 1974, as amended (16 U.S.C. 469-469c [12-052]), provides for the preservation of historic and archaeological data that would otherwise be lost as a result of federal construction. The AHPA authorizes the U.S. Department of the Interior to undertake recovery, protection, and preservation of archaeological and historic data. Section 4(a) of the Act requires that the Secretary of the Interior be notified when unanticipated archaeological materials are discovered during construction of a federal project. Section 7(a) limits the amount of funds expended for archaeological data recovery to 1 percent of project expenses. Section 208 of the 1980 amendment of the NHPA establishes a procedure for agencies to request the Secretary of the Interior to waive the 1 percent limitation. Application of the Act to construction of GNEP facilities would be dependent on whether construction of the facilities would be considered a federal undertaking.

12.3.4.3 Archaeological Resources Protection Act

The ARPA of 1979 as amended (16 U.S.C. 470aa et seq. [12-053]) secures the protection of archeological resources and sites on public or Indian lands, and fosters exchange of information between agencies, organizations and individuals having collections or data. The ARPA requires individuals to obtain a permit from the federal land manager for any excavation or removal of archeological resources from public or Indian lands. Excavations must further archaeological knowledge in the public interest. Any resources removed remain the property of the U.S. This Act would apply to GNEP activities on the Roswell site only in the event that activities affected archaeological resources on federal land adjacent to the site in a manner that created the potential for excavation or removal.

12.3.4.4 Antiquities Act

The Antiquities Act (16 U.S.C. 431 et seq. [12-054]) protects historic and prehistoric ruins, monuments, and objects of antiquity (including paleontological resources) on lands owned or controlled by the Federal Government. If historic or prehistoric ruins or objects were found on adjacent federal land during the construction or operation of Roswell site GNEP facilities, a determination of whether adverse effects to these ruins or objects would occur. If adverse effects would occur, the Secretary of the Interior would have to grant permission to proceed.

12.3.4.5 American Indian Religious Freedom Act

The AIRFA (12-009) affirms Native American religious freedom and establishes policy to protect and preserve the inherent and constitutional right of Native Americans to believe, express, and exercise their traditional religions. This law ensures the protection of sacred locations and access of Native Americans to those sacred locations and traditional resources that are integral to the practice of their religions. Further, it establishes requirements that would apply to Native American sacred locations, traditional resources, or traditional religious practices potentially affected by the construction and operation of projects requiring federal action.

The Act directed federal agencies to evaluate policies and procedures, consulting with native traditional religious leaders, to determine changes needed to implement the Act. One of the resulting changes was Executive Order 13007, Indian Sacred Sites (12-051). Executive Order 13007 directs Federal agencies to avoid adverse effects to sacred sites and to provide access to those sites to Native Americans for religious practices to the extent permitted by law and not inconsistent with agency missions. Executive Order 13007 directs agencies to plan projects to provide protection of and access to sacred sites to the extent compatible with proposals.

12.3.4.6 Native American Graves Protection and Repatriation Act

The NAGPRA of 1990 (25 U.S.C. 3001 [12-010]) directs the Secretary of the Interior to guide the repatriation of federal archaeological collections and collections that are culturally affiliated with Native American tribes and held by museums that receive Federal funding. Major actions to be taken under this law include (1) the establishment of a review committee with monitoring and policymaking responsibilities, (2) the development of regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims, (3) the oversight of museum programs designed to meet the inventory requirements and deadlines of this law, and (4) the development of procedures to handle unexpected discoveries of graves or grave goods during activities on Federal or tribal land. The provisions of the Act would be invoked only if any GNEP-related excavations on federal land adjacent to the Roswell site led to unexpected discoveries of Native American graves or grave artifacts.

12.3.4.7 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments

Executive Order 17135 (12-055) directs Federal agencies to establish regular and meaningful consultation and collaboration with tribal governments in the development of Federal policies that have tribal implications, to strengthen United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates on tribal governments. It would apply to the extent that development and operation of the Roswell site had potential consequences for tribes.

12.3.5 National Environmental Policy Act

NEPA (42 U.S.C. § 4321 et seq. [12-057]), as amended, establishes environmental policy and goals for the protection, maintenance, and enhancement of the nation's environment to ensure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing environment. NEPA provides a process for implementing these specific goals within Federal agencies responsible for specific actions. Council on Environmental Quality regulations (40 CFR 1500 through 1508 [12-058]) set out general guidelines for implementing NEPA requirements during review of all proposed federal actions including licensing of nuclear facilities, approval of sites for those facilities, and use of nuclear materials.

Individual federal agencies have also adopted implementing regulations. DOE's NEPA implementing regulations are found at 10 CFR 1021 (12-097). NRC's NEPA implementing regulations are found at 10 CFR 51 (12-069).

12.3.6 Federal Land Policy and Management Act

The FLPMA (43 U.S.C. 1701 et seq. [12-011]) governs the use of Federal lands administered by the Bureau of Land Management. Access to and use of public lands administered by the Bureau are primarily governed by the regulations regarding the establishment of rights-of-way (43 CFR 2800 [12-059]) and withdrawals of public domain land from public use (43 CFR 2300 [12-060]). It could have application to the Roswell site if utility or transportation routes across adjacent federal land were required for construction or operation of GNEP facilities.

12.3.7 Hazardous Materials Packaging and Transportation

Both the U.S. DOT and the NRC regulate the safe transportation of radioactive materials. The DOT is responsible for transportation safety standards for hazardous materials, including radioactive materials. The NRC regulates packaging- and transportation-related operations of its licensees, which include commercial shippers of radioactive materials. The NRC sets design and performance standards for packaging (shipping casks) that carry materials with higher levels of radioactivity. The DOT accepts NRC packaging standards set out at 10 CFR 71 (12-061).

12.3.7.1 Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (49 U.S.C. 1801 [12-062]) authorizes DOT to regulate hazardous materials transportation, including the transportation of radioactive materials. DOT requires identification of hazardous materials during transportation, regulates route selection, and provides guidance to states in selecting preferred routes.

12.3.7.2 Department of Transportation Hazardous Materials Packaging and Transportation Regulations

DOT regulates the shipments of hazardous materials, including spent nuclear fuel and high-level radioactive waste, in interstate and intrastate commerce by land, air, and navigable water (49 CFR Subchapter C - Hazardous Materials Regulations, Parts 171 through 180 [12-064]). DOT regulates spent nuclear fuel carriers, as well as conditions of transport, e.g., routing, handling, storage, and vehicle and driver requirements. It also regulates labeling, classification, and marking of transportation packages for radioactive materials. DOT regulations include requirements for carriers, drivers, vehicles, routing, packaging, labeling, marking, placarding of vehicles, shipping papers, training, and emergency response, and specifications for maximum dose rates and maximum allowable levels of radioactive surface contamination on packages and vehicles.

DOT routing regulations (49 CFR Subchapter C - Hazardous Materials Regulations, Part 397 [12-065]) are intended to reduce the impacts of transporting radioactive materials, to establish consistent requirements for route selection, and to establish terms for state and local participation in route selection.

12.3.7.3 Nuclear Regulatory Commission Radioactive Materials Packaging and Transportation Regulations

The NRC regulates packaging and transport of spent nuclear fuel for its licensees, including commercial shippers and federal carriers (10 CFR 71 [12-061]). The NRC also sets standards for Type B packages, including packages carrying spent nuclear fuel. Type B packages are designed and built to retain their radioactive contents in both normal and accident conditions.

The NRC also sets standards for safeguards and physical security during the shipments of spent nuclear fuel (10 CFR 73 [12-063]). These regulations include requirements for vehicles, carrier personnel, communications, notification of states, escorts, and route planning.

12.3.8 Emergency Planning and Community Right-to-Know Act

EPCRA (12-056) requires facilities to provide information on certain hazardous and toxic materials to state emergency response agencies, local emergency service providers, and EPA. EPCRA is intended to promote the ability of emergency providers to respond to unplanned releases of hazardous substances.

Sections 311 and 312 of EPCRA require facilities with regulated quantities of hazardous substances on site to provide an inventory of certain hazardous substances to the State Emergency Response Commission, Local Emergency Planning Committee, and the local fire department. EPCRA does not place limits on which chemicals can be stored, used, released, disposed, or transferred at a facility. It only requires a facility to document, notify, and report information (12-125).

Section 313 of EPCRA requires facilities that meet certain threshold requirements to report releases to the environment and off-site transfers of certain listed chemicals. This Toxic Release Inventory Report must be submitted to both EPA and the State Emergency Response Commission; however, EPA is predominantly responsible for implementation of EPCRA Section 313.

The requirements set forth in the EPCRA are only applicable during facility operations.

12.4 State Regulatory and Permitting Requirements

This section addresses New Mexico regulatory and permitting requirements that may apply to the Roswell site if selected for siting of GNEP facilities.

12.4.1 New Mexico Construction Permits and Approvals

This section describes the state permit requirements for design and construction of industrial facilities that would be located at the Roswell site in support of GNEP.

12.4.1.1 New Mexico Construction Industries Division Approval

The New Mexico Construction Industries Division (CID) is responsible for the review and approval of commercial building plans and the issuance of building permits. All construction projects in the State of New Mexico are required to obtain a building permit before construction begins. Plans for a proposed building project are submitted to the Division, which reviews the plans to verify compliance with electrical, mechanical, and general construction code requirements adopted by the State of New Mexico ([12-031). The New Mexico Building Codes are found at Title 14, Chapters 7-11 NMAC (12-030). Prior to the submission of plans to the CID, approval for the project must be obtained from the appropriate city and county planning and zoning departments and the appropriate city and county building departments.

The CID also conducts inspections during the building process to evaluate code compliance and safety. No building may be occupied until a certificate of occupancy is issued by the CID (12-031).

12.4.2 New Mexico Air Quality Program

The EPA has delegated responsibility to New Mexico for carrying out the requirements of the federal Clean Air Act (CAA) (12-025). The NMED Air Quality Bureau (AQB) has responsibility for carrying out the requirements of the CAA throughout New Mexico, except for Bernalillo County (Albuquerque) and Indian lands (12-025). The Bernalillo County/City of Albuquerque Air Quality Management Division is responsible for the air quality in Bernalillo County (12-023, 12-025). Indian lands are regulated directly by U.S. EPA Region VI and Region IX (12-041).

12.4.2.1 Proposed Site Attainment Status

Geographical areas that do not meet all NAAQSs are designated by EPA as non-attainment areas. The proposed GNEP site is not in a non-attainment area. At present there are two federal non-attainment areas in New Mexico, a two square mile area at Anthony, NM that is nonattainment for PM10 and a larger area near Sunland Park, New Mexico that is marginally nonattainment for O_3. There is also a maintenance area for SO_2 that is defined as a circle with a 3.5-mile radius around the Phelps Dodge Smelter in Grant County. The area near Anthony, the closest of these three to the proposed GNEP site, is nearly 200 miles from the proposed site. Three others areas in New Mexico approach ambient air quality standards. Section 10.3.4 provides information on the nonattainment areas and the maintenance area as well as a map that shows the areal extent of each and its location in relation to the proposed GNEP site (Section 10, Weather/Climatology).

The proposed GNEP site is located in Chaves County, which is currently considered to be in attainment of all state and national ambient air quality standards (12-028. The only exceedances in Chaves County are for particulate matter 10 microns or less in diameter (PM_{10}) (blowing dust) in the vicinity of the City of Roswell, approximately 40 miles west of the site. NMED is currently developing a NEAP for Chaves County (12-029). The NEAP will require Best Available Control Measures to minimize blowing dust for anthropogenic sources.

12.4.2.2 Construction Permit

Owners and operators of a new stationary source that has a potential emission rate of greater than 10 tons per year of any regulated air contaminant are required to file a notice of intent with the AQB prior to the commencement of construction (12-027). All new stationary sources require an AQB review of emission controls and projected emission rates in comparison to adopted standards of performance for new stationary sources (40 CFR 60 [12-072]).

Construction permits are required for all sources with a potential emission rate of greater than 10 pounds per hour or 25 tons per year of any regulated air contaminant for which there is a national or a state ambient air quality standard and for sources that may emit hazardous air pollutants (12-027).

The regulations require public notice of the proposed permit and include a 30-day public comment period (20.2.72.206). If there is significant public interest in an application for a construction permit, NMED will hold a public hearing (12-027).

12.4.2.3 Operating Permit

Title V of the CAA (12-003) and 40 CFR 70 (12-076) and 40 CFR 71 (12-077) require an operating permit for major emission sources. A major source is one that emits or has the potential to emit (considering controls) 10 tons per year or more of any hazardous air pollutant or 25 tons per year of all hazardous air pollutants of any combination of hazardous air pollutants or 100 tons per year or more of any air pollutants (including any fugitive emissions).

If the proposed facilities constitute a major emission source, the owner/operator will need to submit a Title V permit application to the NMED AQB. Issuance of this operating permit would be required prior to construction of process facilities (12-027).

New Mexico defines major sources as sources that emit or have the potential to emit 100 or more tons per year of any air pollutant, as well as major sources under Section 112 of the CAA (20.2.70 NMAC, referencing Part 70 sources). If the proposed facilities fall within this definition, the owner/operator will be required to obtain an operating permit from the NMED (12-027).

The regulations require public notice of a proposed permit and include a 30-day public comment period. NMED may hold a hearing if it determines that a public hearing is needed or based on significant public interest (12-027).

AQB regulations include emission standards for hazardous air pollutants, which adopt the national emission standards in 40 CFR 61 (20.2.78 NMAC). A Part 70 operating permit is required for any source that is subject to Section 112 of the Federal Act (HAPs) unless the source “would be required to obtain a permit solely because it is subject to regulations or requirements under Section 112(r) of the Federal Act” (12-027).

12.4.2.4 NAAQS/Proposed Facility Emissions (Major/Minor Source)

NAAQS have been adopted by EPA for particulate matter (PM10 and PM2.5), carbon monoxide, sulfur oxides, nitrogen oxides, ground-level ozone and lead.

The New Mexico Air Quality Control Act (NMSA §74-2-1 et seq. [12-026]), and implementing regulations (NMAC 20.2.1 et seq. [12-027]), establish threshold levels of potential emissions rates that determine if an owner or operator is required to file a notice of intent and obtain a construction permit and/or operating permit. Major sources are required to obtain an operating permit pursuant to 20.2.70 NMAC (12-027).

The State of New Mexico has established ambient air quality standards at 20.2.3 NMAC (12-027). The regulations establish standards for total suspended particulates, sulfur compounds, carbon monoxide, and nitrogen dioxide. The AQB monitors for ozone, nitrogen oxide, sulfur dioxide, carbon monoxide, particulate matter and lead. The ambient concentrations of contaminants are compared to the health-based NAAQS (12-028).

12.4.3 Wastewater and Water Quality

12.4.3.1 New Mexico Environment Department Discharge Permit

The New Mexico Water Quality Act (NMSA §74-6-1 et seq. [12-085]), and implementing regulations, NMAC 20.6.2 (12-086), apply to discharges of water that may affect either groundwater or surface water. A Notice of Intent (NOI) to Discharge is required for new water contaminant discharges that may affect either groundwater or surface water. Discharge permits are required for discharges that may move either directly or indirectly into groundwater. It is likely that the proposed facility will be required to obtain a groundwater discharge permit for various aspects of operations, including septic and sanitary discharges.

The purpose of a discharge permit is to control discharges of water contaminants from a facility into ground and surface water in order to protect ground and surface water and to protect public health. A single discharge permit usually covers all discharges of water contaminants from the proposed facility, including discharges into evaporation ponds, site storm water retention basins, and wastewater treatment systems (domestic sewage generated at the facility). The requirements for discharge permit applications and the discharge plan are set forth in NMAC 20.6.2.3106 and 3107. A groundwater discharge permit includes specific operational, monitoring and reporting, closure, and requirements for all of the permitted discharges.

Within 30 days of submitting a discharge plan application, the applicant is required to provide public notice of the discharge permit application. The application undergoes review by the NMED Water Quality Bureau (WQB) to determine if the application is administratively complete. Once the application is administratively complete, the WQB publishes an additional notice and there is a public comment period during which comments may be made on the discharge permit and a public hearing may be requested. A hearing will be held if the Secretary of the NMED determines that there is a significant public interest (12-086).

The New Mexico Liquid Disposal and Treatment regulations (20.7.3 NMAC [12-035]), apply to on-site liquid waste systems that are designed to receive and do receive two thousand (2,000) gallons or less of liquid waste a day and that do not generate discharges that require either an NMED groundwater discharge permit or an NPDES permit. Given the expected size of the proposed facility, it is likely that the wastewater treatment system at the site will require a groundwater discharge permit and would not fall within the Liquid Disposal and Treatment regulations.

12.4.3.2 Water Quality Certification (Section 401)

The State of New Mexico’s role in this process is to certify that NPDES-permitted projects comply with state water quality standards (12-086) in accordance with Section 401 of the CWA, which is implemented in 40 CFR 121 (12-098). NMED is the state agency responsible for implementing the Section 401 certification process (12-086).

After EPA issues a draft permit and provides public notice, the agency provides the proposed final permit to the NMED for certification. The NMED usually has 30 days to issue or deny its certification. CWA Section 401 certification is required for any permit or license issued by a federal agency for any activity that may result in a discharge into waters of the state to ensure that the GNEP facilities will not violate state water quality standards. The NMED must grant, deny, or waive Section 401 certification for a project before a federal permit or license can be issued (12-086).

12.4.4 Drinking Water, Well Drilling, and Underground Injection

EPA implements and enforces primary drinking water standards under the SDWA to protect the quality of public water supplies (12-006, 12-021, and 12-022). EPA has delegated portions of its regulatory responsibility under the Act to states and tribes, including the state of New Mexico.

Drinking water provided at the facility will be governed by the SDWA. Because of the delegation to New Mexico, no federal permit will be required for the drinking water system. Facility owner/operators will need to submit an application for construction of its public drinking water supply system to the NMED Drinking Water Bureau. System owner/operators will also need to be certified by the Bureau.

During operation, the drinking water system will be monitored. Drinking water monitoring results will be reported to NMED or local agencies.

In addition to direct protection of potable water systems, the SDWA establishes protection for sole source aquifers, regulates underground injection of contaminants, mandates measures for wellhead protection, and directs the regulation of septic systems.

12.4.4.1 Drinking Water System Operating Permit

The NMED Drinking Water Bureau regulates public drinking water systems pursuant to 20.7.10 NMAC (12-035). A “public water system” is defined as a system that provides water for human consumption the has at least fifteen service connections or regularly serves an average of twenty-five individuals daily for at least 60 days out of the year. The State of New Mexico has adopted the National Primary Drinking Water Regulations and the National Secondary Drinking Water Regulations (12-035).

Prior to construction of a public water drinking system project, an application must be filed with the Drinking Water Bureau for review and approval. The regulations do not provide for public notice or hearings for applications for a public drinking water system project.

12.4.4.2 Well Drilling Permit

The procedures to obtain a permit to withdraw underground water from a well in New Mexico are set forth in the New Mexico Water Code (Chapter 72 NMSA), at §§72-12-1 et seq. The procedure calls for an applicant to file an “Application for Permit to Appropriate Underground Waters,” with the NMOSE. The information required on the application is: (1) the particular underground stream, channel, artesian basin, reservoir or lake from which water will be appropriated; (2) the beneficial use to which the water will be applied; (3) the location of the proposed well; (4) the name of the owner of the land on which the well will be located; (5) the amount of water applied for; (6) the place of the use for which the water is desired; and (7) if the use is for irrigation, the description of the land to be irrigated and the name of the owner of the land. Normally the well driller is listed on the application along with the well depth and casing size. The State Engineer provides public notice of the application to put other water rights owners in the area on notice provide an opportunity for objections. If an objection is made, an administrative hearing process is held; if no objections are filed, the Water Code requires that the State Engineer grant the application and issue a permit, providing he/she finds that the proposed appropriation would not impair existing water rights, is not contrary to conservation of water within the state and is not detrimental to the public welfare of the state. An owner of an existing right may file an application to change the location of an existing well, and/or to change the place and/or purpose of use of waters drawn from an existing well. Any such application follows the same notice and protest procedure.

Permits for rights that would supply water to the proposed GNEP facilities have been obtained.

12.4.4.3 Injection Well

Underground injection wells, other than those associated with oil and gas production, are regulated under the general ground water protection requirements found at 20.6.2.3000 to 20.6.2.3114 NMAC (12-086) and under the Underground Injection Control section at 20.6.2.5000 to 20.6.2.5210 NMAC. All types of underground injection wells, except those associated with oil and gas production, must meet groundwater discharge permit requirements. The underground injection control regulations impose technical requirements on injection well used for effluent disposal an *in-situ* extraction.

An injection well permit would not likely be sought for this site. Hydraulic connectivity beneath the site is low and there is substantial potential for contamination of potable groundwater supplies.

12.4.5 Solid and Hazardous Waste Management

The RCRA[2] governs the treatment, storage and disposal of hazardous waste (42 U.S.C. §§6921 to 6931 [12-017]). RCRA regulations apply to persons who generate, transport, store, treat and/or dispose of hazardous waste. RCRA establishes standards for the treatment, storage and disposal of hazardous waste and requires persons engaging in the treatment, storage or disposal of hazardous waste to obtain a permit. Section 3006 of RCRA (42 U.S.C. §6926) allows States to establish and administer hazardous waste permit programs with EPA approval.

EPA regulations implementing RCRA are found at 40 CFR 260 through 272 (12-018). The regulatory requirements imposed on a generator of hazardous waste or on a treatment, storage and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored and/or disposed. Methods of treatment, storage, and/or disposal also impact the extent and complexity of the requirements.

The EPA has authorized the State of New Mexico to implement the RCRA program. The New Mexico statutory provisions governing hazardous waste are found in the Hazardous Waste Act (HWA), NMSA 74-4-1 et seq. (12-013). The hazardous waste regulations are found in Title 20, Chapter 4, Part 1 (20.4.1) (12-014) of NMAC. The HWA regulations, with some exceptions, adopt Federal RCRA regulations. Requirements for hazardous waste facility permits are found at 20.4.1.500 NMAC (12-014) (incorporating 40 CFR 264 (12-018)) and 20.4.1.900 NMAC (12-014) (incorporating 40 CFR 270 (12-018)). The HWA and HWA regulations are administered by the NMED Hazardous Waste Bureau (HWB). If a proposed facility includes the storage, treatment or disposal of hazardous waste above certain threshold levels, the facility will be required to obtain a permit from NMED.

In the case of mixed waste, that is waste that contains both hazardous and radioactive components, the state has jurisdiction only over the hazardous component of the waste. States such as New Mexico that are authorized to implement the RCRA program in lieu of EPA may only "apply the RCRA regulations to the hazardous component of mixed waste, regardless of the classification of the radioactive component as low-level, high-level, transuranic, or other" (EPA State Authorization Manual, Vol. II, Appendix N, U.S. EPA OSWER Directive 9540.00-9A-1, October, 1980 [12-024]).

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[2] The Resource Conservation and Recovery Act (RCRA) amends the Solid Waste Disposal Act (SWDA), which is discussed below in Section 12.8.3

12.4.5.1 Hazardous Waste Facility Siting Criteria

New Mexico has adopted the federal regulations governing the location of new hazardous waste facilities that are contained in 40 CFR, 264.18 and 270.14(b)(11) (12-011, 12-012, 12-025). These regulations place restrictions on siting new facilities, including restrictions on locating facilities in environmentally sensitive areas (12-022). Section 264.18 specifically prohibits the location of a new hazardous waste TSDF in the following locations:

- Within 200 feet of a fault that has had displacement in Holocene time (40 CFR 264.18(a)),
- Within a 100-year floodplain unless the facility is designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood or other specific provisions are met (40 CFR 264.18(b)), or
- In a salt dome, if the waste being placed is a non-containerized or bulk liquid (40 CFR 264.18(c)).

The characteristics of the Roswell site meet these location requirements, as evidenced by NMED’s issuance of the Triassic Park Hazardous Waste Facility Permit in 2002 (12-042).

12.4.5.2 RCRA Treatment, Storage and Disposal Facility Permit

Facilities that treat, store or dispose of hazardous waste above certain threshold levels must obtain a TSDF Permit. The standards for owners and operators of TSDFs are found at 40 CFR 264 (12-018), adopted by New Mexico at 20.4.1.500 NMAC (12-014). The regulations include general standards for the protection of groundwater, closure and post-closure and financial assurance. The regulations also include standards for the design, construction, operation and maintenance of specific types of TSDFs.

In March, 2002, the NMED HWB issued the Triassic Park HWDF permit for 480 acres of the proposed site (12-042). The permit is valid for 10 years and allows for specific types of treatment, storage and disposal. If a TSDF permit is needed for the proposed facility, the Triassic Park permit may have to be modified to meet the specific treatment, storage or disposal requirements for the facility. The needed modifications could be identified during the design phase of the facility, and, if identified before the permit is renewed in 2012, could be included as part of the permit renewal process. Depending on the needs of the facility, the modifications could include changes in the footprint of the Triassic Park facility or changes in the types of waste permitted or in the treatment, storage and disposal methods allowed. The permit renewal process is an established and fairly predicable process before the HWB.

NMAC 20.4.2 (12-014) requires permit application fees that would likely be in excess of $100,000. Fees are also assessed for permit modifications and other annual fees would be applicable. NMAC 20.4.3 (12-014) provides for fees on Large Quantity Generators (LQG) of $0.01 per lb of hazardous waste generation and an annual business fee of $2,500.

The procedure for obtaining a TSDF permit begins with submission of a permit application to the NMED HWB. The HWB reviews the application to determine if it is administratively complete. A request for additional information is usually made in the form of a notice of deficiency, identifying one or more elements of the permit application that are not complete. NMED is allowed one year to evaluate an application after an application is deemed complete. When the evaluation is finished, the HWB either issues a draft permit or a notice of intent to deny the permit application (20.4.1.900.A(1) NMAC [12-014]).

The HWB offers the public a number of opportunities to comment on permit applications. Although not specifically required by the regulations, public notice is often given notice that a permit application has been filed with the HWB and public informational meetings may be held. The regulations require that public notice be given that a draft permit has been issued (12-014).

The applicant and the public have 45 days to review and comment on the draft permit and to request a hearing. If a public hearing is requested, the procedures in 20.1.4 NMAC (12-015) become applicable. Interested individual and entities, including members of the public, may participate in the public hearing, either as parties to the hearing or by submitting oral or written comments during the hearing. NMED uses HWA regulations, as well as general permit procedures (20.1.4 NMAC [12-015]), when a permit application goes to public hearing.

The HWB regulations require NMED and the permit applicant, to respond to any requests for a public hearing "in an attempt to resolve the issues giving rise to the opposition" (12-014).

12.4.5.3 Generator Requirements

The standards applicable to generators of hazardous waste are found at 40 CFR 262 (12-018), adopted by New Mexico at 20.4.1.300 NMAC (12-014). There regulatory requirements vary according to the amount of hazardous waste generated on a monthly basis. Large quantity generators (LQGs) generating more than 2,205 pounds per month are required to obtain an EPA identification number. 40 CFR 262.12 (12-018). A LQG may accumulate hazardous waste on-site for up to 90 days without a permit as long as the regulatory requirements of 40 CFR 262.34(a) (12-018) are met. Generators who accumulate hazardous waste for less than 90 days must comply with storage standards for containers and tanks, and conduct proper operating, maintenance, and inspection procedures.

Conditionally exempt small quantity generators, less than 100 kilograms (220 pounds) of hazardous waste per month, are required to follow the regulations in 40 CFR 261.5 (12-018) but are not subject to the generator requirements in Part 262 (12-018).

Small quantity generators, more than 100 kilograms but less than 1,000 kilograms (2,200 pounds) of hazardous waste per month, may accumulate up to 6,000 kilograms (13,230 pounds) of hazardous wastes for 180 days, or 270 days if the wastes must be transported 200 miles or more for treatment or disposal, without obtaining a permit. 40 CFR 262.34(d) (12-018).

LQGs that accumulate wastes onsite for more than 90 days are classified as operators of hazardous waste storage facilities and must obtain a RCRA storage permit, as discussed in Section 12.8.1.

12.4.5.4 Solid Waste Management and Disposal

The SWDA regulates solid wastes. 42 U.S.C. §6903(27) (12-019). The New Mexico Solid Waste Act, NMSA 74-9-1 et seq. (12-040) and implementing regulations, NMAC 20.9.1 et seq (12-016), govern the disposal of solid waste, as defined by the Solid Waste Act. Solid waste must be disposed of in a regulated, permitted solid waste facility (NMAC 20.9.1.106 [12-016]). Solid waste does not include "any material regulated by Subtitle C of the federal RCRA of 1976, substances regulated by the federal Toxic Substances Control Act or low-level radioactive waste." NMSA 74-9-3.N(9) (12-040). A solid waste facility is a "public or private system, facility, location, improvements on land, structures or other appurtenances or methods used for processing, transformation, recycling or disposal of solid waste, including landfill disposal facilities, transfer stations, resource recovery facilities, incinerators and other similar facilities not specified, but does not include…a facility which is permitted pursuant to the provisions of the HWA" (NMSA 74-9-3.P [12-040]).

The regulations state that no person shall "process, recycle, transfer, transform, or dispose of radioactive waste including low level radioactive waste in a solid waste facility; however, nothing in this section shall prohibit the storage or disposal of radioactive materials or radioactive waste from a uranium mine or mill pursuant to a license or other authorization from the U.S. NRC or the state" (NMAC 20.9.1.107(I) [12-016]). This provision does not apply to the proposed facility because the facility will not be a solid waste disposal facility.

12.4.6 Hazardous Materials Packaging and Transportation

The DOT regulations allow state routing agencies to designate preferred transportation routes for radioactive materials as alternatives to, or in addition to, interstate highway systems (40 CFR §397.101(b)(1) [12-065]). The New Mexico Radiation and Hazardous Materials Act authorizes the State Transportation Commission, except as specifically preempted by Federal law, to designate highway routes for the transport of radioactive material (§ 74-4A-1 NMSA 1978 [12-087]). Route designations within the State are required to be consistent with DOT regulations. If the State does not designate routes, the routes are determined by the applicable DOT regulations.

The Transportation Commission has designated routes for the WIPP. These routes were approved by DOT (65 Fed. Reg. 75771 (Dec. 4, 2000) [12-088]).

12.4.7 Historical, Tribal and Cultural Resources

12.4.7.1 National Historic Preservation Act

The NHPA (12-008) was enacted to create a national historic preservation program, including the NRHP and the Advisory Council on Historic Preservation. The NHPA provides for the placement of sites with significant national historic value on the NRHP. It requires no permits or certifications.

12.4.7.2 Section 106 Consultation

Section 106 of the NHPA requires Federal agencies to determine if their actions would affect historic resources. If a potential for effect on historical resources is found, the agency is required to consult with the Advisory Council on Historic Preservation and the SHPO for the state in which the resources exist. Such consultations generally result in the development of agreements that include stipulations to be followed to minimize or mitigate potential adverse impacts to historic resources. Federal regulations found at 36 CFR 800 (12-050) set forth procedures for initiating and conducting the Section 106 process.

The facility could apply for and obtain a solid waste permit on a different portion of the site for the small amount of non-hazardous solid waste it generated as discussed above or it could rely on off-site permitted solid waste disposal facilities if reasonably available.

12.4.8 Hazardous Materials Information, Planning, and Management

The New Mexico Hazardous Chemicals Information Act, § 74-4E-1 to 74-4E-9 NMSA 1978 (12-034) implements EPCRA's informational requirements in the State of New Mexico. Any facilities that are required to file written notice under EPCRA are required to provide such information to the SERC (74-4E-5) (12-034).

The State of New Mexico, through the Department of Public Safety, has promulgated an "All-Hazard Emergency Operations Plan," which establishes the state emergency operations system. The plan sets forth lines of authority, responsibilities and organizational relationships and the coordination between the State and federal and local governments in the case of an emergency. (12-033).

The State of New Mexico does not require a permit to store hazardous materials. Pursuant to the New Mexico Occupational Health and Safety Act (OSHA), 50-9-1 et seq., NMSA 1978 (12-036), an employer who has hazardous chemicals on site is required to ensure that the chemicals are properly labeled and that Material Safety Data Sheets are available. The employer is required to maintain a current inventory of the hazardous chemicals and must have a written hazard communication program and provide training on hazardous chemicals. The employer is also required to maintain records and reports that are consistent with the OSHA records and report requirements of the United States Department of Labor. The NMED has the right to enter and inspect the place of employment at reasonable times. The New Mexico OSHA regulations are found at Title 11, Chapter 5 of the New Mexico Administrative Code (12-037).

12.4.9 State Involvement in Licensing Radioactive Materials

The NRC has authority under the AEA to relinquish to the states certain portions of its licensing and regulatory authority. This includes programs for by-product materials, source material and certain quantities of special nuclear materials. The state Governors may enter into agreements with the NRC to assume such programs. The State of New Mexico does have an agreement with the NRC (12-089).

The New Mexico Radiation Protection Act, NMSA §74-3-1 et seq. (12-038) requires that persons possessing, storing, processing or altering radioactive material have a license issued either by the NRC, an agreement State or the New Mexico Environment Department. The Act and its implementing regulations, NMAC 20.3.1 et seq. (12-039), require either demonstration of compliance with the Act and regulations or demonstration that the proposed activity is exempt from the provisions of the Act or regulations. If the licensee has a license issued by either the NRC or an agreement state, the licensee is required to notify NMED of the license. The requirements of the Radiation Protection Act and implementing regulations do not apply to 'the mining, extraction, processing, storage or transportation of radioactive ores or uranium concentrates that are regulated by the NMBMMR, or any other Federal or state agency having authority unless the authority is ceded by such agency to the [Environmental Improvement] Board.'

12.5 Regional and County Regulatory and Permitting Requirements

12.5.1 Local Land Use Plans and Zoning Ordinances

The Roswell site is located in Chaves County, New Mexico. The site consists of 920 acres of undeveloped property surrounded by undeveloped ranch land. The site owners' ranch house is located 2.4 miles from the site. Two other residences exist within 5 miles of the site. The site is comprised of 480 acres located in Sections 17 and 18, Township 11 South, Range 31 East, N.M.P.M., Chaves County, New Mexico and 440 acres located in Section 17 (NE1/4; E1/2SW1/4; E1/2NW1/4; W1/2SE1/4; NE1/4SE1/4). The two parcels are contiguous. The property is solely owned by Gandy Marley, Inc., a New Mexico Corporation and one of the applicants. Four hundred and eighty acres of the site are zoned for industrial use; conversion of the rest from agricultural zoning to industrial is practicable. Robert W. Marley, a principle of Gandy Marley Inc., owns 10,000 acres of ranch land contiguous to the proposed site (see Figure 14-1 in Section 14, Storage Capability). The land to the west of the site is owned by the U.S. BLM and is leased by Robert W. Marley for cattle grazing. There are no other partners or lien holders that could affect the designation of the property for the proposed facility.

The Chaves County Zoning Ordinance, dated May 30, 1984, is applicable to the proposed site (12-084). There are no other applicable local codes or ordinances. The underlying zoning for Chaves County is agricultural or rural suburban. Accepted uses in the areas include farming, ranching, single family residences, parks, schools, and similar type uses. Other land uses require a special use permit or a change of zoning. Pursuant to the zoning ordinance, development of the proposed facility will require a special use permit and a certificate of zoning.

12.5.1.1 Industrial Use Zoning Status

On September 25, 1996, a 480-acre portion of the proposed site designated as the Triassic Park facility was issued a Certificate of Zoning for "Industrial zoning for a treatment, storage and disposal facility for hazardous waste" (12-083).

12.5.1.2 Compatibility of Classification

The existing Certificate of Zoning is specifically for a hazardous waste facility. Because the current zoning is for that use, an additional Certificate of Zoning for the proposed facility would need to be acquired from the Chaves County Commission. The process for obtaining the certificate would include an application to the Chaves County Commission, staff review, and a public hearing on the application. Compatibility issues concerning surrounding land uses, if any exist, would be identified and treated in the special use permit proceeding.

12.5.2 Building Permits

Chaves County requires building permits for all construction projects within Chaves County and has established procedures for acquiring a building permit (12-082). In order to construct a facility in Chaves County, a local building permit must be issued by the county building inspector. The Uniform Building, Mechanical, Plumbing, and Electrical Codes are used throughout Chaves County. The County inspects and enforces the building permit except for electrical, mechanical and plumbing, which are inspected by the state building inspector.

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* Indicates those sources considered but not cited.

CONTENTS

TABLES

13. CONSTRUCTION COSTS

Reed Construction Data provide industry standard, fast, and reliable construction cost estimating tools (13-002). Their products allow accurate comparison of construction costs in different cities or regions of the country. Use of the Reed Construction Data estimating tools ensures a common construction cost base for the GNEP program. Cost comparisons are built using:

- City cost indexes,
- Productivity rates, and
- Crew composition.

Each of these functions is supported by collecting current data from all facets of the industry and organizing it in a readily accessible format. To facilitate comparisons, the U.S. 30-city average cost index is set at 1.0. Areas with a cost index greater than 1 have higher than average construction costs and areas with a cost index less than 1 have lower than average construction costs.

13.1 Relative Costs for Heavy Construction Projects

The relative costs for heavy construction in the Roswell area were taken from the RS Means CostWorks Heavy Construction 2007 data (13-001). The weighted average cost factor for all elements of materials and installation in the Roswell area is 0.891. This implies that heavy construction in the Roswell area is currently less expensive than average U.S. heavy construction costs. Additional detail on material and installation for individual unit cost factor elements relating to heavy construction is provided in Tables 13-1 and 13-2.

Table 13-1. Heavy construction material and installation assembly factors (reproduced from CostWorks 2007 ©2006) (13-001).

Division	Material	Installation	Total
Assembly Factors			
A Substructure	1.020	0.789	0.884
B10 Shell: Superstructure	1.021	0.753	0.919
B20 Exterior Closure	1.233	0.656	0.959
B30 Roofing	0.989	0.734	0.895
C Interior Construction	0.949	0.681	0.836
D10 Services: Conveying	1.000	0.809	0.947
D20-D40 Mechanical	0.999	0.896	0.876
D50 Electrical	0.840	0.753	0.803
E Equipment and Furnishings	1.000	0.702	0.963
G Site Work	0.917	1.100	1.044
A-G Weighted Average	1.001	0.746	0.891

Table 13-2. Heavy construction material and installation cost factors (reproduced from CostWorks 2007 ©2006) (13-001).

Division	Material	Installation	Total
Unit Cost Factors			
01590 Contractor Equipment	0.000	1.156	1.156
02 SITE CONSTRUCTION	0.894	1.102	1.043
02300 Earthwork	0.698	1.102	1.038
02400, 02450 Tunneling and Load-bearing Elements	0.934	1.176	1.059
02700 Bases and Pavements	1.195	1.125	1.188
02500, 02600 Utility Services and Drainage	1.123	0.652	1.083
02800 Site Improvements	1.092	1.239	1.150
02900 Planting	0.854	1.100	0.968
03 CONCRETE	1.158	0.692	0.937
03100 Concrete Forms and Accessories	0.971	0.890	0.729
03200 Concrete Reinforcement	1.172	0.545	0.866
03300 Cast-in-Place Concrete	1.012	0.749	0.913
03400 Precast Concrete	1.461	0.839	1.380
04 MASONRY	1.224	0.542	0.876
04050 Basic Masonry Materials and Methods	1.042	0.737	0.903
04200 Masonry Units	1.250	0.535	0.881
04400 Stone	1.189	0.639	0.831
04500 Refractories	0.979	0.661	0.599
05 METALS	1.019	0.809	0.955
05100 Structural Metal Framing	0.861	0.796	0.843
05200, 05300 Metal Joists and Decking	1.093	0.819	1.004
05500 Metal Fabrications	1.000	0.678	0.947
06 WOOD AND PLASTICS	0.945	0.704	0.818
06100 Rough Carpentry	0.911	0.704	0.776
06200 Finish Carpentry	0.991	0.691	0.959
07 THERMAL AND MOISTURE PROTECTION	0.989	0.725	0.883
07100 Dampproofing and Waterproofing	0.921	0.691	0.730
07200, 07800 Thermal Fire and Smoke Protection	1.002	0.584	0.890
07400, 07500 Roofing and Siding	0.968	0.876	0.930
07600 Flashing and Sheet Metal	1.000	0.767	0.819
08 DOORS AND WINDOWS	0.932	0.678	0.866
08100-08300 Doors and Frames	0.949	0.678	0.879
08800, 08900 Glazing and lazed Curtain Walls	0.966	0.664	0.844
09 FINISHES	0.957	0.681	0.819
09200 Plaster and Gypsum Board	0.847	0.691	0.754
09300, 09400 Tile and Terrazzo	0.959	0.700	0.828
09500, 09800 Acoustical Ceilings and Treatment	1.009	0.691	0.817
09600 Flooring	1.000	0.700	0.920
09700, 0990 Finishes and Painting	0.996	0.576	0.745
DIVISION 10-14	1.000	0.795	0.968
15 MECHANICAL	0.999	0.696	0.876
150-152, 154 Plumbing, Piping, Fixtures and Equipment	1.000	0.692	0.859
15300, 13900 Fire Protection/Suppression	1.000	0.710	0.816
15500 Heat Generation Equipment	0.992	0.695	0.883
15600-15800 Air Conditioning and Ventilation	1.000	0.676	0.961
16 ELECTRICAL	0.840	0.763	0.803
1-16 WEIGHTED AVERAGE	1.001	0.746	0.891

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CONTENTS

14. STORAGE CAPABILITY

The Roswell site is located in the arid high desert ranchland of east-central New Mexico's Chaves County, 40 miles east of Roswell. The area surrounding the Roswell site is sparsely populated (less than 0.2 persons per square mile within a radius of 20 miles) undeveloped ranchland currently zoned for agricultural use (Figure 1-6) and is used primarily for cattle grazing. A portion of the Roswell site (480 acres) is currently zoned industrial for storage, treatment, and disposal of hazardous waste.

14.1 Proposed Storage Capability

There are no existing nuclear storage facilities of any kind present on the site or within 10 kilometers (6 miles) of the site. There is a surface waste management facility, permitted to accept oilfield wastes, located approximately 1 mile northeast of the Roswell site (see Section 15, Other Facilities). There are no facilities at the surface waste management facility that are suitable for storage of nuclear materials.

The 920-acre Roswell site exceeds the minimum size requirement for locating both the Consolidated Fuel Treatment Center (CFTC) and Advanced Burner Reactor (ABR) facilities (500-acre requirement) leaving 420 acres available to construct virtually any size or number of supporting buffer feed and interim waste product storage facilities for nuclear materials associated with commercial scale operations of CFTC and ABR. In addition, Mr. Robert W. Marley (a principle in Gandy Marley, Inc.) owns all land within 1 mile of the Roswell site center.

14.2 Waste Management Capability

Ultimately, the most important aspect of any waste management/storage program is the ability to disposition the waste effectively and thereby prevent accumulation. The facilities are likely to generate a mixture of high-level waste, mixed waste, transuranic waste, and low-level waste. There are existing or planned federal or commercial facilities and disposition routes for all of these streams. Only interim storage of each stream will be required at the site.

14.3 Bibliography

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***** Indicates those references considered and not cited.

CONTENTS

15. OTHER FACILITIES

The Roswell GNEP site is located in remote eastern New Mexico where opportunity to encounter hazardous materials, facilities, or operations is minimal. The two facilities and activities located within 5 miles of the Roswell site are described below.

15.1 Overview and Summary

Two sites are located within 5 miles of the Roswell site. Neither site involves potentially hazardous materials. The first site is a surface waste management facility located approximately 1 mile northeast of the site. The surface waste management facility is permitted to accept non-hazardous oilfield waste, including hydrocarbon and salt-contaminated debris, mud, soils, sludges, and tankbottoms related to oil and gas production. The second site is a liquid petroleum gas (LPG) distribution pipeline approximately 3.5 miles north of the site.

15.2 Surface Waste Management Facility

Gandy Marley, Inc., owns and operates a surface waste management facility located in Sections 4, 5, 8, and 9, Township 11 South, Range 31 East, New Mexico Prime Meridian Chaves County (See Figures 1-6 and 1-7). The facility is located approximately 1 mile northeast of the Roswell site. The site is permitted by the New Mexico Energy Minerals and Natural Resource Department Oil Conservation Division, Permit No. NM-01-0019 (15-002). The NMED has issued a groundwater discharge permit, DP-1041, for the facility (15-001).

The surface waste management facility is permitted to use lined landfill-type cells for the disposal of oilfield waste classified as non-hazardous by RCRA subtitle C exemption or by characteristic testing. The type of wastes that may be accepted include hydrocarbon and salt-contaminated debris, mud, soils, sludges, tankbottoms, and filters associated with the drilling, operation, and maintenance of oil and gas wells and related operations of the oil and gas industry.

15.3 LPG Pipe Line and Booster Pump Station

An LPG distribution line runs adjacent to State Highway 380 approximately 3.5 miles from the Roswell site. The pipeline is owned and operated by the Kinder Morgan Cortez Gas Pipeline Company. Their offices are located at:

500 Dallas, Suite 1000,
Houston, TX 77002
Telephone (713) 369 8408

The planned booster pump station identified in Section 8, Future Projects is located in T10S R31E Section 35 New Mexico Prime Meridian, approximately 6 miles northeast of the Roswell site boundary. The location of this planned facility is shown in Figure 8-1.

15.4 Airports within 16 Kilometers

There are no major airports within 16 kilometers (10 miles) of the Roswell site. The closest airport is a regional airport located in Roswell approximately 40 miles from the Roswell site. Three additional public-use airports within 50 miles of the Roswell site provide a variety of freight and passenger transportation capabilities. They include: Artesia Municipal Airport in Artesia, Lea County-Zip Franklin Memorial in Lovington, and Tatum Airport in Tatum (see Section 6.9 and Figure 6-10 for more detailed description).

15.5 Bibliography

15-001. Ground Water Quality Bureau. 2005. Discharge Plan Modification, DP-1041 letter, Gandy-Marley Inc. Landfarm. August 25, 2005. State of New Mexico Environment Department.

15-002. New Mexico Oil Conservation Division. 2006. Letter regarding Permit No. NM-01-0019. January 17, 2006. Issued by Roger C Anderson, Environmental Bureau Chief, State of New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division.

CONTENTS

FIGURES

TABLES

16. INCLUSION ON NATIONAL PRIORITIES LIST / CERCLIS DATABASE

This section discusses whether the Roswell site, or any portion thereof, is on the National Priorities List (NPL) or is included in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) database.

16.1 Overview and Summary

A search of EPA's NPL database established that no part of the Roswell site appears on the NPL or has ever appeared on it. A search of EPA's CERCLIS database similarly established that no part of the Roswell site has appeared or has ever appeared in CERCLIS.

16.2 National Priorities List

The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation. NPL sites can be identified at http://www.epa.gov/superfund/sites/npl/npl.htm (16-001). Information regarding new and proposed NPL sites and the cleanup progress related to those sites is also available on the NPL website. Table 16-1 documents the current status of the proposed site and identifies any nearby NPL sites. Figure 16-1 identifies the location of Superfund sites in New Mexico.

Table 16-1. Current status of the proposed site and nearby NPL sites (16-001).

Current Listing Status	The Roswell site is not currently listed on the NPL.
Past Listing Status	The Roswell site has never been listed on the NPL.
Adjacent or Nearby Sites	A search of EPA's NPL database identified no other NPL sites within a 20-mile radius of the proposed site. No sites located within a 20-mile radius of the Roswell site have ever been listed on the NPL. The nearest listed site, the McGaffey and Main Groundwater Plume (NPL number NM0000605386), is located within the city limits of Roswell, New Mexico, approximately 35 miles from the Roswell site. No other NPL sites exist within 50 miles of the Roswell site.

16.3 CERCLIS Database

The CERCLIS database contains EPA's Superfund data, including information on listed hazardous waste sites and related laws and regulations. EPA administers the Superfund program to locate, investigate, and clean up the worst hazardous waste sites throughout the United States. The CERCLIS database was searched using the search tool found at http://www.epa.gov/enviro/html/cerclis/cerclis_query.html. Table 16-2 documents the current status of the proposed site and identifies any nearby CERCLIS sites.

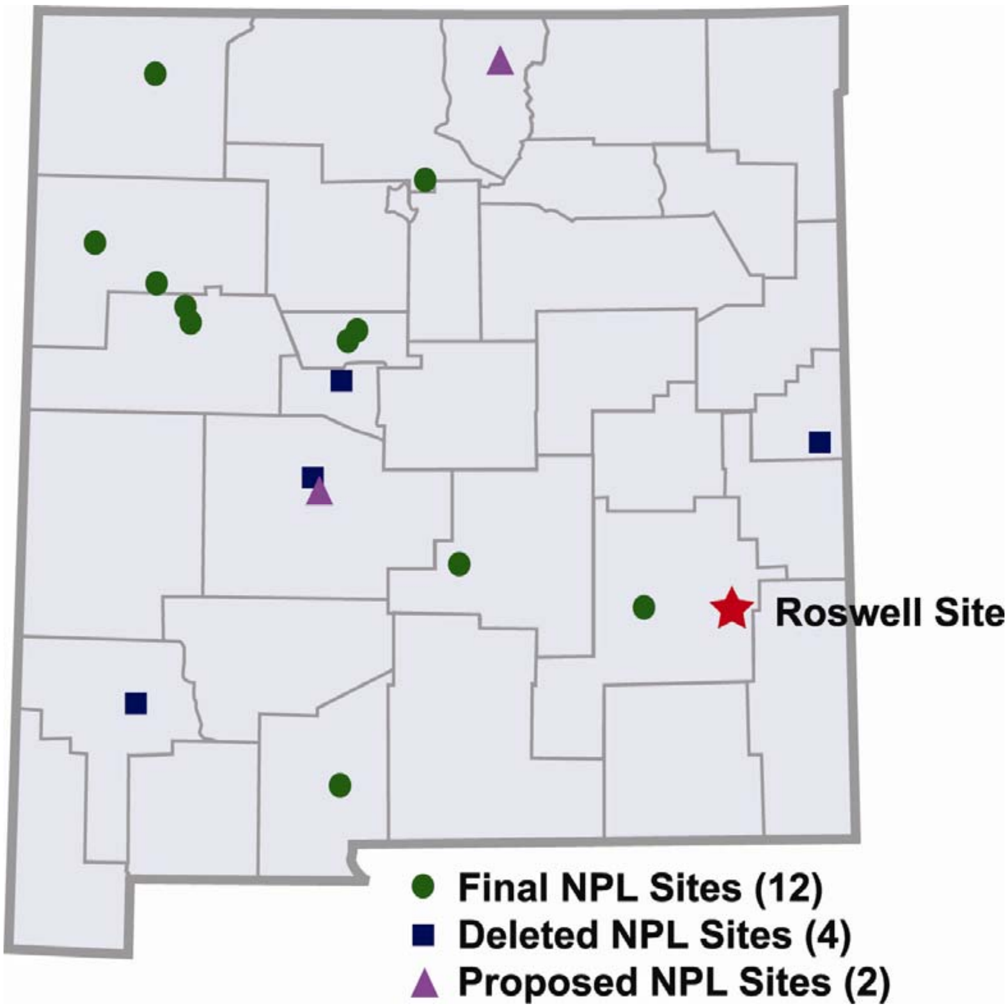

Figure 16-1. Location of Superfund sites in New Mexico.

Table 16-2. Current status of the Roswell site and nearby CERCLIS sites (16-002).

Current Listing Status	The Roswell site is not currently listed in the CERCLIS database.
Past Listing Status	The Roswell site has never been listed in the CERCLIS database.
Adjacent or Nearby Sites	A search of EPA's CERCLIS database identified no other sites located within a 20-mile radius of the Roswell site. No sites within a 20-mile radius of the Roswell site have ever been listed in the CERCLIS database. The nearest listed sites, the McGaffey and Main groundwater plume, (CERCLIS ID: NM0000605386), Roswell 5th and Main, (CERCLIS ID: NM0000192682), and Roswell Industrial Air Center, (CERCLIS ID: NMD981147200), are located in Roswell, New Mexico, approximately 35 miles from the Roswell site.

16.4 Bibliography

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CONTENTS

FIGURES

2. AQUATIC AND RIPARIAN ECOLOGICAL COMMUNITIES

This section describes aquatic and riparian ecological communities that occur within or are near the Roswell site that have the potential to be disturbed by construction and operation of the GNEP facilities. More detailed information on general plant and animal communities that occur at the Roswell site is provided in Section 4, Critical and Important Terrestrial Habitats. Special status species (i.e., species covered under the Endangered Species Act (ESA) or of special concern to other federal, state, or local agencies), including any aquatic or riparian habitat related species, are discussed in Section 5, Threatened or Endangered and Special Concern Species. More detailed surface water hydrology information about the site is presented in Section 11, Hydrology/Flooding.

2.1 Overview and Summary

The Roswell site proposed for construction of the GNEP facilities is at a remote location that has no fish or shellfish present due to a lack of surface water at or near the site. Nevertheless, important habitat areas surrounding this site have been addressed in sufficient detail to allow for the proposed environmental reviews.

Review of the aquatic and riparian communities surrounding the Roswell site led to the conclusions that:

- There is no aquatic, riparian, or wetland habitat at the Roswell site.
- There is one man-made pond (Red Tank) near the center of the Roswell site that collects rainstorm runoff, but it does not support any aquatic, riparian, or wetland vegetation.
- A number of aquatic, riparian, or wetland communities exist within an 80-kilometer (50-mile) radius of the Roswell site. The Pecos River is the nearest large river and is located approximately 30 miles away from the site at its nearest point. These areas would not be affected by construction or operation of the GNEP facilities.

2.2 Background

The aquatic and riparian community evaluation has three focal points: (1) research and review of existing literature and information sources to identify any previously described aquatic communities, including fish and shellfish, commercial and sport fisheries, and riparian communities at or near the Roswell site, (2) research and review of applicable laws and regulations, and (3) a detailed field survey to obtain data and information resulting from the background research. The following subsections provide the technical context of aquatic and riparian communities, the regulatory framework, and the results of the literature search and field survey.

2.2.1 Literature Review Methodology

To quantify the presence or absence of aquatic and riparian communities within the Roswell site, a number of databases, documents, maps, manuals, and pertinent regulations were examined. An aquatic ecological community contains species “Living or growing in, on, or near the water” (2-014). The word “riparian” describes the bank of a body of flowing water and includes the land adjacent to a river or stream that is influenced, at least periodically, by flooding. A riparian ecosystem has a high water table due to the proximity to an aquatic ecosystem such as a stream or river (2-015). Wetlands are defined as “Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions" (2-013). Ephemeral or intermittent streams are much more common in arid landscapes than are aquatic, riparian, and wetland ecological communities. Ephemeral streams are those that only last a short time, such as during spring runoff periods or during extended high rainfall events (2-014). Similarly, intermittent streams are recurrent, may cease for a time, or may only have water in them part of the time (2-014). Both ephemeral and intermittent streams are generally not considered aquatic, riparian, or wetland areas because water flow, availability, and season of availability is not conducive to meeting the requirements of aquatic, riparian, or wetland systems.

The primary regulation applicable to aquatic and riparian ecological communities is the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.) enacted in 1977, and amended in 1987. This is the primary federal statute that addresses water pollution in the United States. The U.S. Environmental Protection Agency (EPA) administers programs established under the CWA. Implementing regulations define Waters of the U.S., which include wetlands. Section 404 of the CWA requires wetland identification, delineation, and protection if wetlands could be impacted by a proposed action and outlines a permit program governing the discharge or placement of dredged or fill material into the Waters of the U.S. Many wetlands are considered to be jurisdictional and, as such, are subject to permitting requirements under the jurisdiction of the U.S. Army Corps of Engineers (USACE). The 1987 USACE Wetland Delineation Manual (2-013) describes the characteristics necessary to designate an area a wetland. These characteristics are related to hydrophytic vegetation, hydric soils, and hydrology. For more information on regulations related to aquatic and riparian habitat see Section 12, Regulatory and Permitting.

Prior to conducting field surveys, information related to the Triassic Park Hazardous Waste Disposal Facility (HWDF) permit application, aerial photography, and topographic maps were reviewed for possible locations of aquatic and riparian ecological communities. The National Wetland Inventory (NWI) (2-011) was consulted to help identify whether or not aquatic, riparian, or wetland areas might be found within the Roswell site boundary; no data were available within that database for the Roswell site. The USGS 7.5-minute quadrangle maps and the BLM Surface Management Status map were also reviewed for presence of water courses within the Roswell site. The Natural Resources Conservation Service (NRCS) databases were searched for evidence linking the Roswell site with soil types and range sites indicative of aquatic and riparian habitats (2-012).

2.2.2 Field Survey Methodology

Field surveys to collect site-specific information on aquatic and riparian ecological communities for the Roswell site were conducted from February 26 to March 2, 2007. A crew of six personnel was used and included both botanists and wildlife biologists. Surveys were conducted by walking parallel transects at 49-foot intervals across the entire 920-acre site. The presence/absence of aquatic and riparian communities was assessed and documented by a wetland delineation specialist. The December 2006 Interim Regional Supplement to the USACE Wetland Delineation Manual: Arid West Region (the Supplement) (2-001) contains new delineation forms, procedures, and criteria that are mandatory for compliance with permitting requirements. The Supplement was utilized to determine presence or absence of wetlands within the Roswell site.

2.3 Results

This section describes general ecological characteristics of aquatic communities, including fish and shellfish, commercial and sport fisheries, and riparian communities at the Roswell site that could be affected by operation or construction of the GNEP facilities. Significant aquatic, riparian, and wetland areas within approximately 50 miles of the Roswell site are also briefly discussed.

2.3.1 Literature Review Results

Previous studies for the Triassic Park HWDF describe the land as arid and documented that there were no flood plains, wetlands, or riparian areas on or adjacent to the Roswell site (2-009). A number of springs occur along the Mescalero Ridge east of the Roswell site; however, water from these springs does not cross the Roswell site. There are also a number of scattered ponds on top of Mescalero Ridge, but these are 1 mile or more from the Roswell site and do not support any wetland communities. The Pecos River, a north-south flowing river that runs through Roswell, is located approximately 35 miles west of the Roswell site at its nearest point. The two areas of the Bitter Lake NWR are located east and north of the city of Roswell; the Bottomless Lakes State Park is southeast of Roswell; and the Overflow Wetlands Area of Critical Environmental Concern (ACEC) is located at the southern end of the Park. These areas are discussed in more detail in Section 2.3.3.

The Roswell site lies within a region of transition between the northern extension of the Chihuahuan Desert and the Southern High Plains (2-010). Aquatic and riparian ecological communities do not commonly exist on these types of sites. Review of the NRCS databases (2-012) indicate that the primary soils are the Faskin-Roswell complex (Sandy Plains and Sandhills Ecological Sites), Roswell-Jalmar complex (Sandhills and Deep Sand Ecological Sites), Alama loam (Loamy Ecological Site), and Ima fine sandy loam (Sandy Plains Ecological Site). A detailed description of these soil types and associated ecological sites is provided in Section 4, Critical and Important Terrestrial Habitats. None of the ecological sites described in Section 4 are associated with aquatic, riparian, or wetland areas. Previous studies indicate the Roswell-Faskin-Jalmar Complex is present on the sandy slopes within the Roswell site, while the Alma Series is restricted to topographically lower drainage areas.

2.3.2 Field Survey Results

No aquatic, riparian, or wetland ecological communities were located on the Roswell site during the survey. There was no evidence of natural aquatic sites and no aquatic, riparian, or wetland ecological habitats exist within the Roswell site. There are a few dry drainages that cross the site from east to west, but they are ephemeral and do not retain water to the degree that aquatic, riparian, and wetland ecological communities require. The absence of these communities was documented by a wetland delineation specialist and confirms findings from previous studies that the land is arid and that there are no flood plains, wetlands, or aquatic communities on or adjacent to the site (2-009).

There is one man-made pond (Red Tank) near the center of the Roswell site that collects rainstorm runoff, but it does not support any aquatic, riparian, or wetland vegetation (see Figure 2-1). In addition to providing water to livestock, a number of bird species and some mammals use the pond. Because of the time of year when the survey was completed, identification of plants, especially grasses and forbs, was largely dependent upon senescent plant material and standing litter on the Roswell site.

Figure 2-1. Red Tank Pond located within the Roswell site.

Native vegetation within the Roswell site is typical of the desert region and, although vegetation varied somewhat by soil type, it is typically dominated by honey mesquite (*Prosopis glandulosa*), creosote bush (*Larrea tridentata*), broom snakeweed (*Gutierrezia sarothrae*), shinnery oak (*Quercus havardii*), various perennial grasses (*Aristida* spp., *Bouteloua* spp., *Sporobolus* spp.), and a few forbs and cacti. For further information regarding vegetation communities, see Section 4, Critical and Important Terrestrial Habitats.

2.3.3 Nearest Aquatic/Riparian Communities

The field survey of the Roswell site did not identify any aquatic or riparian habitat within the required boundaries. Consequently, there are no aquatic, riparian, or wetland physical or biological attributes to describe for the Roswell site. Figure 2-1 shows Red Tank, the only water body found on the Roswell site. Red Tank is a clay-lined, man-made pond that collects rainwater runoff and supports no riparian vegetation or aquatic communities. The remainder of the site is arid high desert and a full description of habitat is provided in Section 4, Critical and Important Terrestrial Habitats.

There are a number of aquatic and riparian areas found within 50 miles of the Roswell site. These include springs within approximately 2 miles to the east (i.e., Mescalero Ridge springs) and significant aquatic, riparian, or wetland areas approximately 35 miles west of the Roswell site near the city of Roswell (i.e., Pecos River, the Bitter Lake NWR, the Bottomless Lakes State Park, and the Overflow Wetlands ACEC). None of these areas would be affected by consumptive water use at the Roswell site. Therefore, the following subsections only briefly describe each of these major aquatic or riparian areas.

2.3.3.1 Mescalero Ridge Springs

The Mescalero Ridge springs are located over 1 mile from the Roswell site and drain from the face of Mescalero Ridge, one of the most prominent topographic features in southeastern New Mexico. The springs exist where the Ogallala Formation crops out, east of the Roswell site, along the 200-foot high Mescalero Ridge escarpment. In these locations the Ogallala sands unconformably overlie impermeable Dockum mudstones and claystones and the groundwater moves laterally to the surface, creating the springs. Where these water-bearing Ogallala sands are in contact with more permeable units of the Upper Dockum, saturation of these underlying sediments occurs. The result is the formation of a groundwater divide east of the Roswell site (2-009). Biological attribute data are unavailable for the Mescalero Ridge springs; however, springs typical of this area do not support fish and/or shellfish communities.

2.3.3.2 Pecos River

The Pecos River, a north-south flowing river, runs near Roswell, approximately 35 miles west of the Roswell site at its nearest point. The riparian vegetation community along the Pecos River is tied to landform within the flood plain and is influenced by flooding intervals. The landform is comprised of exposed and stabilized river bars, the flood plain, and terraces (2-008). Typical riparian vegetation along the Pecos River banks include pockets of Baltic rush (*Juncus balticus*), threesquare (*Schoenoplectus pungens*), and cattail (*Typha* spp.). Woody vegetation within the lower flood plain include seepwillow (*Baccharis salicifolia*), coyote willow (*Salix exigua*), saltcedar (*Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*). Alkali sacaton (*Sporobolus airoides*), alkali muhly (*Muhlenbergia asperifolia*), and inland saltgrass (*Distichlis spicata*) are the most common grass species. Common forb species include goldenrod (*Solidago* spp.), ragweed (*Ambrosia* spp.), Douglas rabbitbrush (*Chrysothamnus viscidoflorus*), prairie sunflower (*Helianthus petiolaris*), and sweet whiteclover (*Trifolium ripens*). Older cottonwood (*Populus* spp.) trees can be found in several areas and typically occur on higher elevation sandbars and terraces above the active flood plain (2-008). Numerous avian, mammal, herptile, and fish species utilize the Pecos River and associated riparian areas.

2.3.3.3 Bitter Lake National Wildlife Refuge

The Bitter Lake NWR is located in two areas along the Pecos River northeast of the city of Roswell. It is one of the more biologically significant wetland areas of the Pecos River watershed system and was established in 1937 to provide wintering habitat for migratory birds. With its gypsum karst topography and unusually diverse wetlands, a variety of plant and animal communities thrive on the refuge. Straddling the Pecos River, the NWR consists of an assortment of water habitats. Numerous seeps and free-flowing springs, oxbow lakes, marshes and shallow water impoundments, water-filled sinkholes, and the refuge namesake, Bitter Lake, make up these unique environments. Scattered across the land are over 70 natural sinkholes created by groundwater erosion that form isolated communities of fish, invertebrate, amphibians and other wildlife. Fishing is prohibited to protect rare native fish (2-002).

The Bitter Lake NWR lies within a significant ecological meeting place where the Chihuahuan Desert, short grass prairie, Pecos River, and the Roswell artesian basin come together and serves as a major focal point for migratory birds such as ducks (*Anas* spp.), geese (*Chen* spp.), sandhill cranes (*Grus canadensis canadensis*), and waterbirds (2-008). Attracted to the area by its abundant water supply, at least 357 species of birds have been observed on the refuge. At least 59 species of mammals, over 50 species of reptiles and amphibians, and 24 fish species have also been documented on the refuge (2-002).

2.3.3.4 Bottomless Lakes State Park

The Bottomless Lakes State Park is located along the Pecos River approximately 12 miles southeast of Roswell. The lakes in the park are water filled sinkholes in the local gypsum terrain. Odd geology and water chemistry creates habitat for unusual plants and animals. The lakes range in depth from 17 to 90 feet. Devil's Inkwell and Cottonwood Lake are stocked with rainbow trout in winter. Unique fish species, such as the Pecos gambusia (*Gambusia nobilis*) and Pecos pupfish (*Cyprinodon pecosensis*), are also found within the park boundaries (2-003, 2-004).

Salt tolerant vegetation, such as alkali bulrush (*Scirpus maritimus*), alkali sacaton, saltgrass, globemallow (*Sphaeralcea* spp.), salt heliotrope (*Heliotropium curassavicum*), tamarisk, four-wing saltbush (*Atriplex canascens*), and seepweed (*Suaeda* spp.) are common, as are upland plants, such as dropseeds (*Sporobolus* spp.), three-awn grasses (*Aristida* spp.), baby aster (*Symphyotrichum porteri*), Drummond's onion (*Allium drummondii*), plains paintbrush (*Castilleja sessiliflora*), creosote bush, plains prickly pear cactus (*Opuntia polyacantha*), and wolfberry (*Lycium* spp.). Many species of birds are commonly found in the park; Lazy Lagoon attracts most of the waterfowl species, while songbirds and raptors can be seen park-wide (2-003, 2-004).

2.3.3.5 Overflow Wetlands ACEC

The Overflow Wetlands ACEC is located approximately 16 miles southeast of Roswell. This area contains critical habitat for threatened and endangered fish species and supports a significant riparian/wetland community. Special status species, such as Pecos pupfish and Pecos gambusia exist within the boundaries of the ACEC (2-007). The Pecos River meanders south for about 5 miles through the western portion of the ACEC. A wide flood plain borders both sides of the Pecos River within the ACEC. The wetland area trends southwest from the Lea Lake area for about 3.5 miles before entering the Pecos River at the most southern point. There are four points along the river where water from the wetlands enters the Pecos River (2-006).

Much of the dry flood plain surrounding the wetlands supports a sparse saline soil plant community featuring iodine bush (*Allenrolfea occidentalis*), seepweed, inland saltgrass, and Trans-Pecos sealavender (*Limonium limbatum*). Only slightly higher ground within the flood plain yields alkali sacaton as the dominant vegetation with mosaics of saltcedar and mesquite. Riparian areas consist of a narrow band along the riverbank dominated by a dense canopy of saltcedar with a sparse understory. Other riparian vegetation includes seep willow, phragmites (*Phragmites communis*), cattail, and sedges (*Carex* spp.) (2-007).

Numerous avian species use the area during spring and fall migration, including game and nongame migratory birds. Common bird species are mourning dove (*Zenaida macroura*), mockingbird (*Mimus polyglottus*), white-crowned sparrow (*Zonotrichia leucophrys*), black-throated sparrow (*Amphispiza bilineata*), western meadowlark (*Sturnella neglacta*), Crissal thrasher (*Toxostoma crissale*), western kingbird (*Tyrannus verticalus*), northern flicker (*Colaptes auratus*), common nighthawk (*Chordeiles minor*), and roadrunner (*Geococcyx californianus*) (2-007).

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* Indicates those sources considered but not cited.

CONTENTS

FIGURES

TABLES

3. WATER RESOURCES

This section addresses the existing ground water and surface water resources that may be affected by construction and operation of GNEP facilities at the Roswell site. The section focuses on the location and quantity of ground water resources and describes the lack of surface water that results from the site's location in the semi-arid ranchland of east-central New Mexico. While there are no known or planned contaminant sources that could impact the local ground water resource, a discussion is provided to evaluate the possibility of transport or migration of contamination from potential sources in the vicinity of the site to the nearby Ogallala aquifer.

The information presented in this section of the document is organized such that there is a logical flow from a technical perspective. To ensure clarity relative to the required water resource elements, a cross-walk between required elements and where the information resides has been provided in Table 3-1.

Table 3-1. Cross-walk for required water resource elements.

Required Information Element	Section / Table / Figure
Describe aquifers potentially impacted by on-site wells	Section 3.2.1.3, Figure 3-5
a. Areal extent	Table 3-8
b. Thickness	Section 3.2.1.3 (storativity reported instead of porosity)
c. Porosity, hydraulic conductivity	
d. Significant uncertainties and inhomogeneities	None identified
Describe existing and known future off-site and on-site wells	
a. Average flow rates	Sections 3.2.2.1, 3.2.2.2,
b. Peak flow rate	Tables 3-2, 3-3, 3-4, 3-5, 3-6, 3-7
c. Water use	Figures 3-3, 3-6, 3-7
d. Completion depth	
Provide maps of steady state piezometric surfaces	Peak pumpage: No data located
a. Wells at peak production	Average pumpage: No data located
b. Wells at average production	No pumpage: Section 3.2.2.4, Figure 3-8
c. Steady state no pumpage	Drawdown: Sections 3.2.2.5, 3.2.2.6
d. Annotate wells according to drawdown contribution	Table 3-9, Figures 3-9, 3-10
e. Identify and describe method of analysis with assumptions	Section 3.2.2.6, Table 3-8
Describe existing and known future ground water rights, including Native American	Sections 3.4.1, 3.4.2, 3.4.2.1, 3.4.2.2 Table 3-12 Figure 3-11
Describe wetlands affected by a lowered water table	Section 3.3.4
Describe potentially affected waters that could receive GNEP facility discharges with classifications	Ground Water: Section 3.2.3 Surface Water: Section 3.3.3
Describe existing environmental contamination with potential to impact ground water quality	Ground Water: Section 3.2.4 Surface Water: Section 3.3.3
If surface water supply is proposed, state and prove unencumbered proof of water right	Section 3.3.3
Describe existing environmental contamination with potential impact surface-water quality	Section 3.3.3
Describe quantity of ground- and surface-water supplies available and proximity to site	Section 3.4.2.1 Table 3-12 Figure 3-11

3.1 Overview and Summary

The Roswell site is situated in the Roswell Artesian Underground Water Basin (UWB), near its boundary with the Lea County UWB. The Roswell UWB is an administrative unit that includes several aquifers, including an alluvial aquifer about 35 miles west of the site along the Pecos River, the Roswell Artesian Aquifer, local perched ground water bodies near the site, and ground water in formations beneath the site. Formations beneath the site yield little ground water and water quality is considered poor. The western boundary of the Ogallala Aquifer coincides with Mescalero Ridge about 1 mile east of the site. The Ogallala is the only aquifer within 10 miles that is known to yield large amounts of ground water, and hence it is a likely source of water for GNEP facilities. The closest major body of perennial surface water is the Pecos River, located approximately 35 miles west of the site at its nearest point. Ephemeral surface water at the site is derived exclusively from local precipitation and snowmelt.

A review of the most current information based on readily available and existing literature led to the following conclusions.

- Water from the Ogallala Aquifer is available within approximately 3.5 miles of the site.
- Ground water beneath the site is not of sufficient quality or quantity to support large scale beneficial use.
- No ground water wells have been completed at the site and no new water production wells are planned or anticipated.
- Ground water extraction from the Ogallala Aquifer will not affect aquatic or riparian communities at or near the site.
- There is no surface water or ground water that would be affected by discharges from the Roswell site.
- The Ogallala Aquifer is not vulnerable to impacts from environmental contamination originating in the vicinity of the site. There are no known sources of contamination that could impact the Ogallala Aquifer near the site.

3.2 Ground Water Resources

The information contained is this section summarizes the hydrogeologic setting and identifies the ground water aquifers that may potentially be affected by operation of onsite or offsite wells. Section 9, Geology/Seismology, discusses and provides background information about the geologic setting of the site and vicinity. Figure 3-1 identifies the administrative UWB for the entire state. The discussion below addresses the Roswell Artesian and Lea County UWBs.

There are two hydrogeologic systems important to siting GNEP facilities at the Roswell site. The hydrogologic system beneath the site in the Roswell Artesian UWB is important from the perspective of low water quality and the limited potential for GNEP operations to affect ground water beneath the site. The second hydrologic system, the Ogallala Aquifer in the Lea County UWB, provides an abundant water supply just a few miles east of the site. As a result, the site is situated in an ideal location because the ground water beneath the site is generally not of sufficient quantity or quality to support significant beneficial use, but an abundant high-quality water source is available nearby. The sections below describe the overall hydrogeologic setting and present details of both aquifer systems.

3.2.1 Hydrogeologic Systems

The New Mexico Office of the State Engineer (NMOSE) has identified UWBs throughout the state. The site is in the Roswell Artesian UWB near its boundary with the Lea County UWB (Figure 3-1). The Roswell Artesian UWB is an administrative unit that includes (3-001):

- An alluvial aquifer along the Pecos River about 35 miles west of the site,
- The Roswell Artesian Aquifer in Upper Permian limestones and dolomite west of the Pecos River,
- The Quaternary Alluvium Aquifer that occurs in unconsolidated surficial sediments and Upper Dockum Formation sediments near the site, and
- The Lower Dockum Aquifer, in the Santa Rosa Equivalent basal sandstone beneath the site.

The Lea County UWB consists of the Ogallala Aquifer, which occurs in the Ogallala Formation that begins about 1 mile east of the site and extends eastward.

The alluvial aquifer along the Pecos River and the Roswell Artesian aquifer west of the Pecos River are unlikely to be affected by the operations at the site because they are far from the site, and are isolated by a thick sequence of low hydraulic conductivity material in Triassic and Permian age formations. These aquifers are not discussed further in this report.

Ground water can be present at several depths near the site. The shallowest ground water is typically at depths of only feet to a few tens of feet below ground surface (bgs) and occurs in unconsolidated sediments of Quaternary age, and in unconsolidated or consolidated sediments of the Upper Dockum Formation. Ground water also occurs at depths of hundreds of feet bgs in the Lower Dockum Formation.

Shallow ground water in eastern Chaves County is sometimes referred to as the Quaternary Alluvial Aquifer. Although Quaternary sediments are present at the site, none were found to be saturated during site characterization activities performed to support the Triassic Park HWDF permit application (3-036). The Upper Dockum Formation consists primarily of mudstone interbedded with siltstone and silty sands. Ground water in the Upper Dockum Formation immediately adjacent to the site has been characterized as perched ground water (3-038). For the purposes of this report, shallow ground water in Quaternary sediments and the Dockum Formation are grouped together and discussed in Section 3.2.1.1

Ground water has been identified deeper in the geologic section in both the Upper and Lower Dockum Formations immediately adjacent to the site. The Lower Dockum Formation consists largely of mudstones interbedded with silty material; however, a basal sandstone unit in the Lower Dockum (termed the Santa Rosa Equivalent in the site vicinity) supports several wells within 10 miles of the site that yield modest amounts of ground water. The Santa Rosa Equivalent basal sandstone was identified in two deep wells drilled during the Triassic Park HWDF characterization studies (WW-1 and WW-2) based on a loss of circulation during air rotary drilling and saturated conditions subsequently observed in the wells (3-038). The deeper ground water system of the Lower Dockum is described in Section 3.2.1.2.

Ground water in the Ogallala Aquifer east of the site is in the Lea County UWB administrative unit. The Ogallala Aquifer occurs in the saturated portion of the Ogallala Formation, which includes coarse textured sediments that yield large quantities of high-quality water to production wells. The Ogallala is a major aquifer in the Great Plains region of the U.S., and is described in more detail in Section 3.2.1.3.

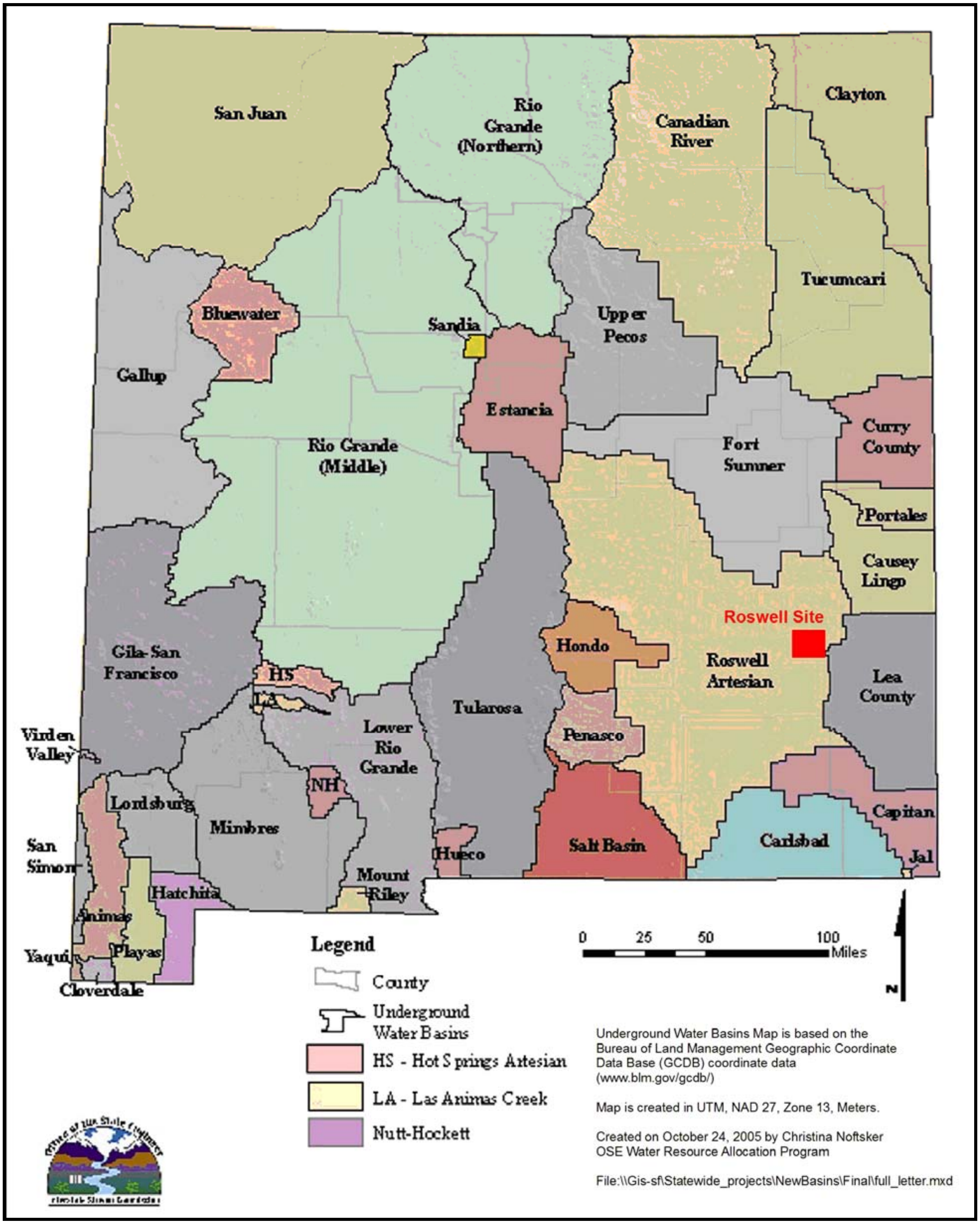

Figure 3-1. Administrative UWBs in the State of New Mexico (3-043).

3.2.1.1 Quaternary Alluvium and Upper Dockum Ground Water Resource

The site is underlain by relatively thin, unconsolidated, Quaternary-age sediments and Triassic-age sediments of the Dockum Formation (see Section 9.2 for more information about the geologic setting of the site). Ground water in the Upper Dockum Formation immediately adjacent to the site has been characterized as perched ground water (3-038). Perched ground water is identified by two criteria. First, the pores in soil or rock are saturated with water such that water will flow into a well. Second, pores in the material beneath the perched zone are not filled with water and thus water will not flow into a well completed in that zone. Perched ground water zones typically occur where a low permeability horizon inhibits downward migration of water and hence water accumulates above that horizon.

Information concerning the shallow hydrogeologic setting (unconsolidated Quaternary sediments and Upper Dockum Formation) and associated ground water beneath the site was developed during site characterization studies conducted on behalf of Gandy Marley, Inc. to support the Triassic Park HWDF permit application (3-035). The information is presented in Attachment H, “Groundwater Monitoring Waiver Request: Triassic Park Facility” (3-038) to the final HWDF permit issued by the New Mexico Environment Department (NMED) in March 2002. During site characterization activities, 50 drill holes were completed on the proposed Triassic Park site, with lithologic and geophysical logs recorded for each of the holes. Data obtained from the drilling program was incorporated in Attachment H. These drill holes were not completed as monitoring wells.

Shallow Perched Water—Perched water zones occur in isolated areas in the Upper Dockum Formation and their spatial extent is unpredictable. The interpreted lateral extent of perched water near the site is based on exploratory drilling during characterization studies for the Triassic Park HWDF permit application. Numerous holes were drilled during Triassic Park characterization studies and most did not encounter perched water. Perched ground water was observed northeast and west of the site, but not beneath the site itself. Perched water was encountered in three holes (PB-1, PB-26, and WW-1) about 0.5 to 1 mile north and northeast of the site, and the perched water bodies were interpreted as having limited areal extent (Figure 3-2). Perched ground water was also detected at a depth of 42 feet in a single drill hole (PB-14), slightly west of the southwest corner of the Triassic Park site. Perched water was not observed in nearby boreholes, indicating that this perched water body had a very limited areal extent. The isolated occurrence of perched water at PB-14 was interpreted as being the result of runoff from precipitation infiltrating and pooling in a stratigraphic trap (e.g., a closed depression in upper surface of a low permeability stratum) where lower permeability material inhibited downward migration of water. The areal extent of perched water near the site identified during the Triassic Park HWDF characterization studies is shown in the upper portion of Figure 3-2.

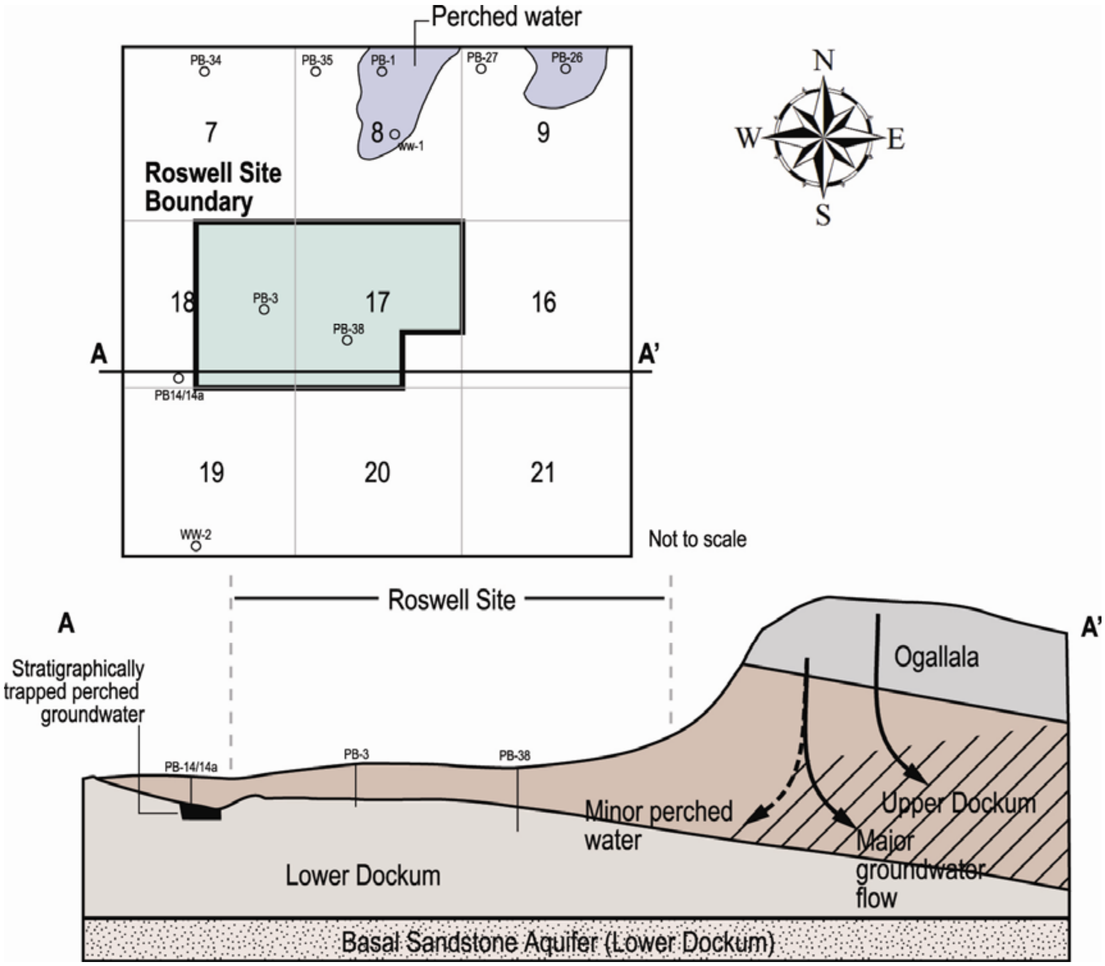

Figure 3-2. Schematic cross section showing flowpaths in the Upper Dockum and Ogallala Formations (3-038).

Perched Water Sources—The cross section in the lower panel of Figure 3-2 illustrates the occurrence of ground water in shallow perched water bodies near the site and regional ground water in the Ogallala Aquifer east of the site. The perched water north of the site is thought to have originated as infiltration of precipitation, migration of ground water that discharged from the Ogallala Aquifer east of the site, or both. Ground water can move laterally along the geologic contact where high permeability Ogallala sediments overlie low permeability Dockum sediments and discharge to the surface at springs. Several springs discharge where the Ogallala Formation-Dockum Formation Group contact is exposed along Mescalero Ridge, an erosional escarpment about 1 mile east of the site. However, there are no springs on the site itself.

In areas where the uppermost sediments of the Dockum formation are more permeable than those beneath, water that discharges from the Ogallala aquifer via springs or underflow can accumulate as perched water in the upper portion of the Dockum formation (Figure 3-2). Springs and underflow migrating from the Ogallala Aquifer into the underlying Dockum Formation is the probable source of most of the perched water in the Upper Dockum Formation in the immediate vicinity of the site. Infiltration of surface runoff is the likely recharge pathway for the small perched water body encountered at boring PB-14. The discharge location for these perched water bodies is unknown.

Perched Water Production—Due to the great variability in lithology of the fluvial Upper Dockum sediments, the occurrence of saturated zones within these sediments is sporadic. No ground water production tests were conducted during Triassic Park HWDF characterization studies due to the difficulty in predicting the location and spatial extent of perched water bodies and the interpretation that these bodies have relatively small lateral extent. No aquifer testing results are known or expected to exist.

During a preliminary geologic investigation conducted for the Triassic Park HWDF permit application, the hydraulic conductivity of three core samples of clayey sediments from the Upper Dockum formation was measured (3-044). The hydraulic conductivity of those three samples was 6×10^{-5} centimeters per second, 1×10^{-7} centimeters per second, and 3×10^{-8} centimeters per second. The porosity of those sediments was not determined. Published porosity values for clay sediments typically range from 33 to 60 percent (3-009). Based on these low hydraulic conductivity values, the perched water zones are not expected to yield sufficient water for industrial use.

The perched water zones detected are not areally extensive and most borings drilled during Triassic Park characterization studies did not encounter perched water. Small zones of perched water were found in isolated small scoured areas at the top of the Lower Dockum Formation. Uncertainties exist in the location of perched water bodies, their productivity, and the lithology in which they occur.

3.2.1.2 Lower Dockum Ground Water Resource

The major aquifer in the Lower Dockum Formation is the Santa Rosa Sandstone, which is a basal sandstone unit. The Santa Rosa Sandstone has been mapped along the northern and southern flanks of the Permian Basin and is a principal source of ground water in Roosevelt and Curry Counties, New Mexico, The Santa Rosa Sandstone has not been mapped as being present along the western flank of the Permian Basin where the site is located (3-038). In spite of the Santa Rosa Sandstone not being mapped in the vicinity of the site, information described below suggests that ground water is present in the Lower Dockum formation near the site.

Lower Dockum Ground Water—Ten water wells completed in Triassic sediments were identified within a 10-mile radius of the proposed Triassic Park site during characterization investigations (Figure 3-3 and Table 3-2). Six of these (RA-8363 and RA-8585 through RA-8589) were drilled to depths of 100 feet or less. This indicates that they are not completed in the basal sandstone, which lies at greater depth. It is not known if these wells are completed in isolated perched water bodies, or in extensive saturated zones at shallower depth than the basal sandstone and there is no recorded pumping rate information. The remaining four wells range in depth from 560 to 640 feet and penetrate Lower Dockum sediments, possibly including the Santa Rosa Sandstone Equivalent, and have produced water at 2 to 6 gallons per minute (gpm). The information for these wells indicates that the Lower Dockum in the vicinity of the site produces little water.

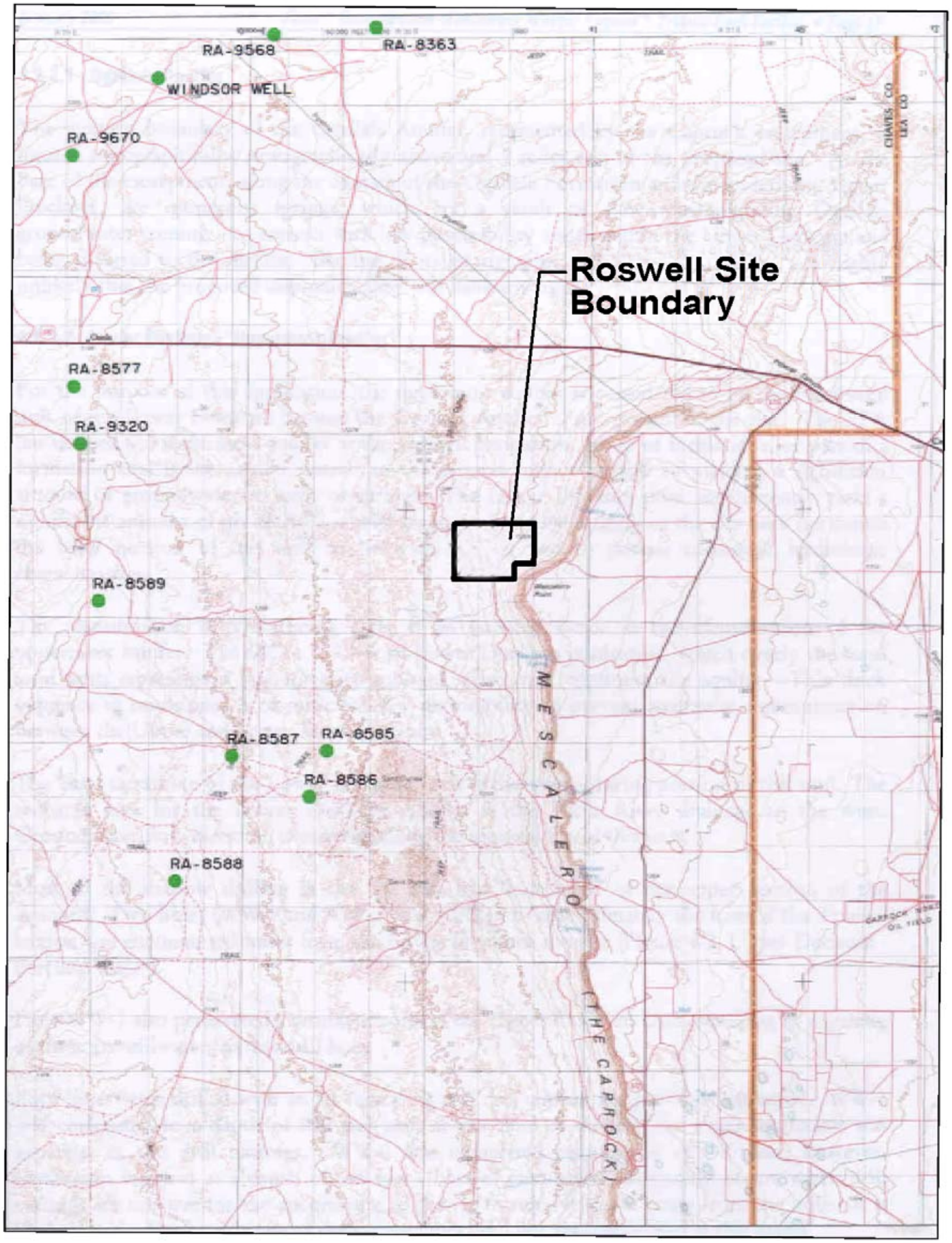

Figure 3-3. Wells completed in Triassic sediments near the Roswell site (modified from 3-038).

Table 3-2. Wells in Quaternary or Triassic deposits within 10 miles of the site (3-036).

Well Identifier	Depth (feet below ground surface)	Water Use	Pumping Rate (gallons per minute)	Formation	Status
RA-8363	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8585	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8586	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8587	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8588	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8589	< 100	Livestock and wildlife	Unknown	Quaternary or Upper Dockum (Triassic)	Unknown
RA-8577	614	Unknown	4	Lower Dockum (Triassic)	Unknown
RA-9320	560	Water non-potable	6	Lower Dockum (Triassic)	Plugged and abandoned
RA-9568	640	Dry hole	N/A	Lower Dockum (Triassic)	Plugged and abandoned
RA-9670	587	Unknown	2	Lower Dockum (Triassic)	Unknown

Exploratory drilling at and near the site during Triassic Park HWDF characterization studies penetrated a basal sandstone unit that was referred to as the Santa Rosa Equivalent (Section 9.2 provides more detail about site geology). Drill holes WW-1 and WW-2 were drilled to approximately the base of the Triassic section and encountered water in the Lower Dockum Formation. These two holes are the only ones drilled deep enough to encounter the Santa Rosa Equivalent during characterization of the Triassic Park HWDF, and hence the areal extent of this unit in the vicinity is unknown, other than it is present within 1 mile north and south of the site boundaries (3-045). The static water level in WW-2, 467 feet bgs, is about 178 feet above the top of the Santa Rosa Equivalent (645 feet bgs), indicating that ground water in the Santa Rosa Equivalent is under confined conditions. The static water level in WW-1, 155 feet bgs, is thought to represent the potentiometric surface in a shallow perched water body penetrated by this borehole. The borehole was not completed to seal off the upper perched system.

Ground Water Flow—There are conflicting descriptions of the direction of ground water flow in the Dockum Formation in the vicinity of the site. According to reports based on characterization of the Triassic Park HWDF (3-036), the recharge area for the Lower Dockum Aquifer is the Pecos River drainage west of the site, and ground water flows easterly, down the regional dip of this unit. In contrast, an earlier study (3-006) indicated that the water table in the eastern portion of the Pecos River Valley slopes toward the west and southwest such that ground water flows toward the Pecos River. It is unclear whether the water level data used to produce water table maps and determine the flow directions in the study were obtained from wells completed in a single aquifer, and the data set used to prepare the water table map is very sparse in the site area. Inconsistencies between the water table elevation map and the depth to water map in the vicinity of the site in the report suggest that there may be errors in the data, or in the interpretation or presentation of water level data in that report. Hence, the interpretation presented in this reference should be reevaluated before use. A BLM (Roswell, New Mexico office) hydrologist indicated that the water table map is generally a good indicator of conditions in the Quaternary Alluvial Aquifer (3-040), which may or may not correspond with conditions at greater depth in the Lower Dockum Formation.

Ground Water Production—The basal sandstone aquifer in the Lower Dockum Formation is believed to be at least 65 feet thick at the location of borehole WW-2. No specific aquifer hydraulic properties of the Lower Dockum Aquifer near the site have been published. Based on known yields from three nearby wells, the Lower Dockum Aquifer is not expected to produce large amounts of ground water. Three wells believed to have penetrated the Lower Dockum Aquifer near the site (RA-8577, RA-9320, and RA-9670) initially yielded ground water at 2 gpm to 6 gpm. Two other holes, RA-9568 and WW-1, were found to be dry at the time the basal sandstone was penetrated (3-038). Yields from wells completed in aquifers near the site are expected to be less than 5 gpm (Figure 3-4) (3-006).

3.2.1.3 Ogallala Aquifer Ground Water Resource

The Ogallala Aquifer is not present beneath the site but begins about 1 mile east and extends hundreds of miles. The Ogallala Aquifer, also referred to as the High Plains Aquifer, is the only aquifer within 10 miles of the site that is known to yield large volumes of ground water (Figure 3-4).

Ogallala Aquifer Ground Water—The western boundary of the Ogallala Aquifer coincides with the Mescalero Ridge escarpment about 1 mile east of the site and extends hundreds of miles to the east, southeast, and northeast (Figure 3-5). It is a major source of fresh water in the Great Plains region of the U.S. One of the world's largest aquifers, it lies under about 174,000 square miles of land in portions of South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas.

Ground Water Flow—The Ogallala Aquifer occurs under water table conditions near the site. Immediately east of Mescalero Ridge, the water table lies at a depth of about 55 to 60 feet bgs, and the saturated thickness of the aquifer is about 60 to 70 feet (3-003, 3-004). On a larger scale, the saturated thickness of the Ogallala Aquifer ranges from a few feet to approximately 300 feet in the Southern High Plains (3-038). The Ogallala Aquifer is recharged primarily by infiltration of local precipitation. The recharge rate near the site is believed to be 1 inch per year or less (3-038). Ground water in the Ogallala Aquifer flows generally to the southeast near the site. The regional hydraulic gradient is approximately 10 to 15 feet per mile. Ground water discharge from the Ogallala Aquifer occurs naturally through springs, underflow, evaporation, and transpiration, but substantial amounts are removed through pumpage. Currently, the rate of withdrawal exceeds the rate of recharge in some parts of the Ogallala Aquifer. Consequently some areas have experienced long-term water level declines. However, hydrographs of six wells within 5 miles of the site show generally stable water levels over the past 40 years (3-003).

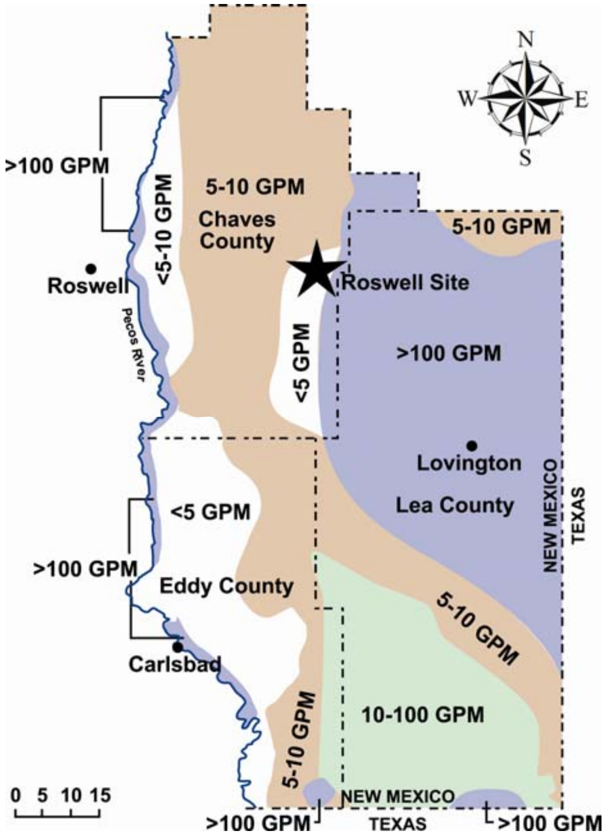

Figure 3-4. Expected yield from ground water wells (3-006).

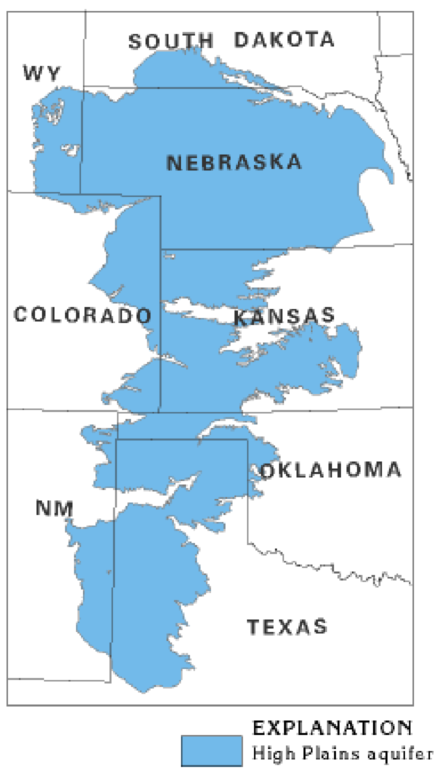

Figure 3-5. Spatial extent of the Ogallala (High Plains) Aquifer (3-007).

Ground Water Production—The saturated thickness in the aquifer near Mescalero Point is approximately 60 to 70 feet and transmissivity is reported to be 10,000 to 30,000 gallons per day (gpd) per foot, or 1,300 to 4,000 square feet per day. Storativity of the aquifer is approximately 0.2 (3-003, 3-004). The expected yield from wells completed in the Ogallala Aquifer is in excess of 100 gpm near the site (3-006) (Figure 3-4).

3.2.2 Ground Water Quantity

Large volumes of high-quality ground water are not available beneath the site itself, due to the low permeability of the rocks and the high concentration of solutes (see Section 3.2.3 for a discussion of water quality). However, large volumes of high-quality ground water are present in the Ogallala Aquifer within a few miles of the site. This section provides an overview of onsite and offsite wells and additional details on well completion, their intended use, and the data that are available for them.

3.2.2.1 Onsite and Offsite Wells

Onsite wells—No ground water wells have been completed at the Roswell site. The formations beneath the site do not yield large quantities of groundwater, and the ground water that is available is of low quality. Therefore, installation of new wells is unlikely. There are no known well installations planned for completion in the Dockum Formation in the vicinity of the site.

Offsite Wells—The nearest offsite wells are found several miles to the east of the site in the Ogallala aquifer east of Mescalero Ridge, and in Quaternary and Triassic sediments west of Mescalero Ridge. Approximately 35 miles west of the site, near the City of Roswell, numerous wells have been completed in an alluvial aquifer adjacent to the Pecos River, and in the San Andres Limestone (also known as the Artesia Group). Wells in the vicinity of the City of Roswell are separated from the site by distance, 35 miles or more, and by low hydraulic conductivity sediments and evaporites of Triassic and Permean age formations that provide an effective barrier against any impact from water production in support of GNEP operations. Consequently, wells in the vicinity of the City of Roswell are not discussed further.

Section 3.2.2.2 summarizes existing wells completed within 10 miles of the site, and Section 3.2.2.3 summarizes known future wells in the Ogallala aquifer.

3.2.2.2 Existing Wells Within 10 Miles of the Site

Although no ground water wells exist at the site and installation of new wells at the site is unlikely due to anticipated low well yields and poor water quality, this section provides information on the relatively few wells completed in Triassic or Quaternary formations nearby. Information about wells in these units within 10 miles of the site, described in documents related to the Triassic Park HWDF permit application, is summarized in Table 3-2 (3-036). The well locations are shown on Figure 3-3.

Two exploratory boreholes drilled during site investigations for the Triassic Park HWDF permit application that extended into the Lower Dockum formation were completed near the Roswell site. WW-1 was drilled about 0.5 miles north, and WW-2 was drilled about 1 mile south. Both were completed with plastic casing to allow measurement of water levels (3-038). Information about these two boreholes is summarized in Table 3-3. In addition, two wells were installed about 1 mile north of the Roswell site near an operating surface waste management disposal facility (3-010). Information about these two wells is also included in Table 3-3.

Table 3-3. Wells completed in Triassic units near the site (3-038 and 3-010).

Well Identifier	Location	Depth (feet below ground surface)	Water Use	Pumping Rate (gallons per day)	Formation	Status
WW-1	0.5 miles north of site boundary	820	Characterization well, water not used	Unknown	Lower Dockum	Unknown
WW-2	1 mile south of site boundary	710	Characterization well, water not used	Unknown	Lower Dockum	Unknown
MW-1	1 mile north of site boundary	203	Not used due to high TDS (8,930 milligrams per liter)	154	Upper Dockum	Completed as monitoring well. Current status unknown
MW-2	1 mile north of site boundary	180	Not used due to high TDS (8,970 milligrams per liter)	206	Upper Dockum	Completed as monitoring well. Current status unknown

TDS = total dissolved solid

Wells completed in the Ogallala Aquifer within 10 miles of the site (see Figures 3-6 and 3-7) were identified from the following databases and records.

- USGS National Water Information System – National Database (3-007),
- Appendices of *Collection of Hydrologic Data Eastside Roswell Range EIS Area New Mexico*, (3-006), and
- Personal communication with the staff of the NMOSE, Roswell District (3-008).

The NMOSE Water Administration Technical Engineering Resource System (WATERS) database is a source of information about wells and water rights in some parts of the state, but the database has not been completely populated with data for the site vicinity.

Based on verbal information provided by NMOSE personnel in the Roswell district office, there are numerous wells in the Ogallala Aquifer in the general vicinity of the site for which few records exist. These are referred to by the NMOSE as “unpermitted wells” and were typically installed 80 to 100 years ago, before obtaining a permit or submitting records to the NMOSE was required, and hence NMOSE files contain little information for many of these wells. These wells are reported to typically produce about 3 acre-feet per year per well for livestock watering (3-008).

Data for wells within 10 miles of the site obtained from the USGS database (3-007) are presented in Table 3-4, and information from *Collection of Hydrologic Data Eastside Roswell Range EIS Area New Mexico* (3-006) is presented in Table 3-5. Wells that are duplicated in these tables are marked with an asterisk. The number in the first column corresponds to the label on the maps (see Figures 3-6 and 3-7). The NMOSE recently granted Gandy Marley, Inc. a permit for well No. L-11,326, which was installed in Section 27, Township 11 South, Range 31 East. Information about the installed well is presented in Table 3-6.

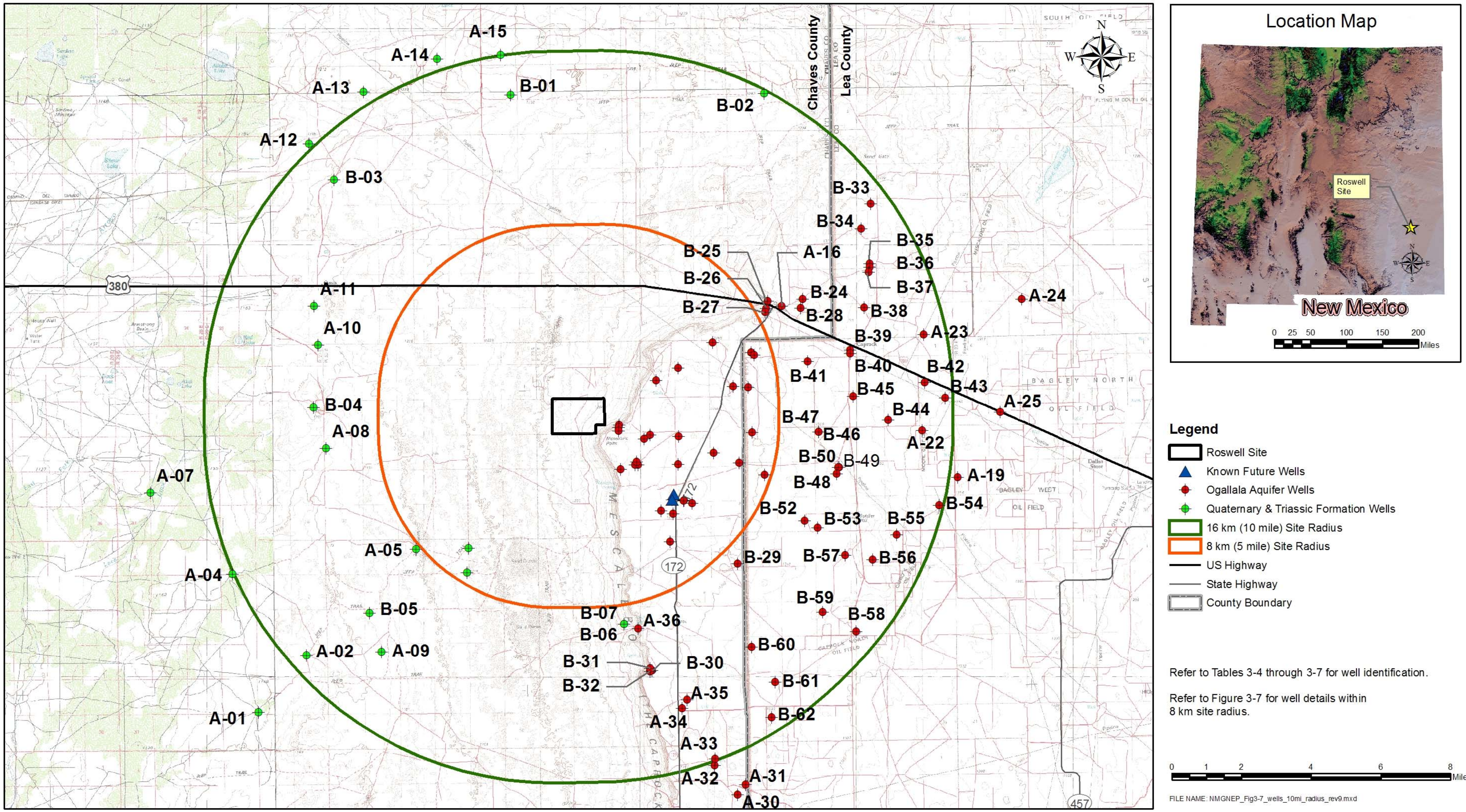

Figure 3-6. Existing wells between 5 and 10 miles of the site cataloged in USGS and NMOSE databases (3-012, 3-013, 3-014, 3-015, 3-016, 3-017, 3-019, 3-021, 3-022, 3-047, 3-049).

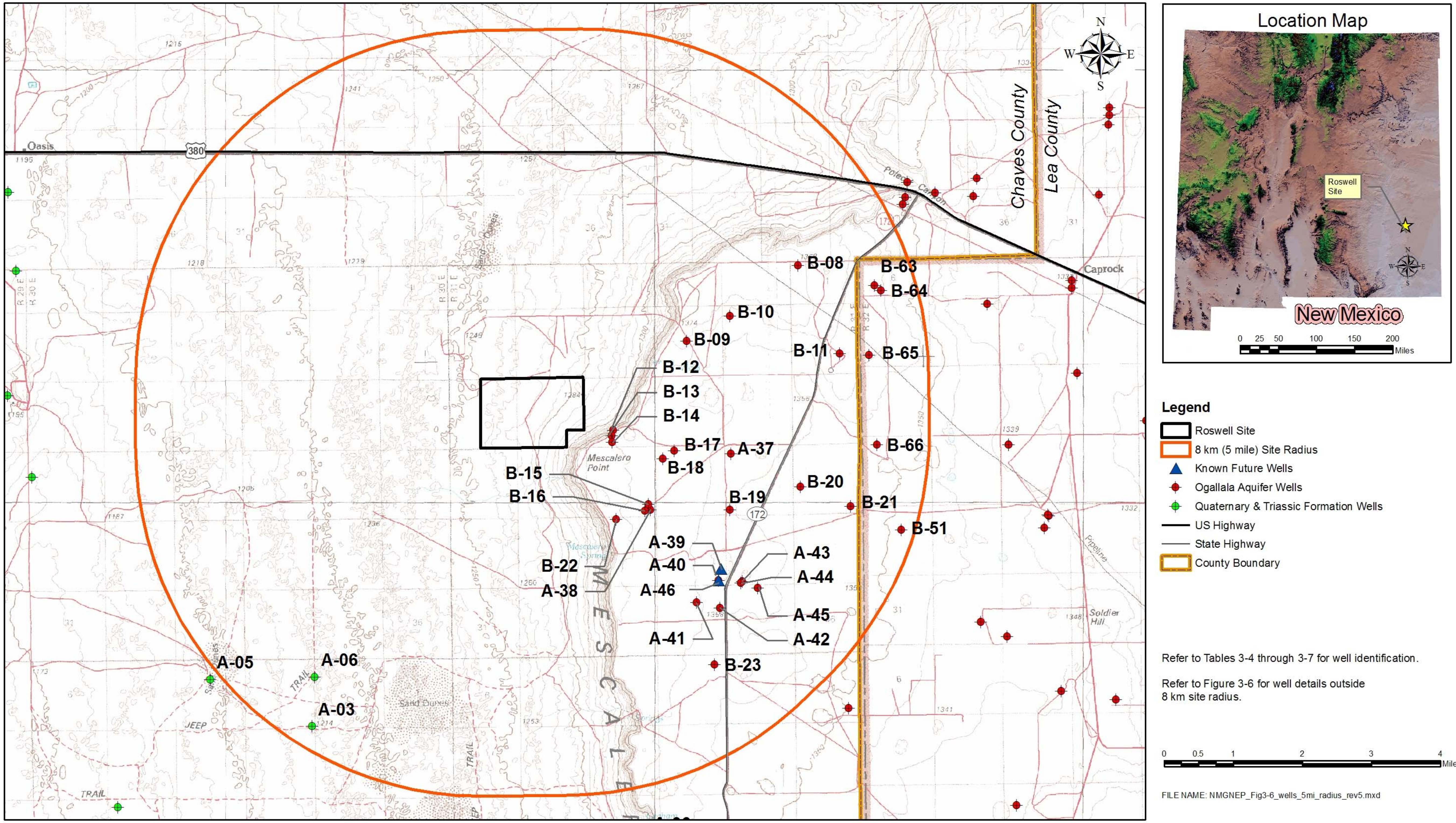

Figure 3-7. Known future wells and existing wells within 5 miles of the site cataloged in USGS and NMOSE databases.

Table 3-4. Characteristics of wells completed in the Ogallala Aquifer within approximately 10 miles of the Roswell site (3-002, 3-027, 3-038).

Well Name on Figures	USGS Well Identifier	Well Location		Well Depth (feet bgs)	Water Use	Average Pumping Rate (gpm)	Maximum Pumping Rate (gpm)
		Latitude	Longitude				
A-01	3101	33º14'32"	104º00'31"	Unknown	Stock	Unknown	Unknown
A-02	590401	33º15'56"	103º59'04"	Unknown	Stock	Unknown	Unknown
A-03	541601	33º17'58"	103º54'16"	Unknown	Stock	Unknown	Unknown
A-04	11501	33º17'59"	104º01'15"	Unknown	Domestic	Unknown	Unknown
A-05*	554701	33º18'34"	103º55'47"	Unknown	Stock	Unknown	Unknown
A-06	541301	33º18'35"	103º54'13"	Unknown	Stock	Unknown	Unknown
A-07	34001	33º20'03"	104º03'40"	Unknown	Stock	Unknown	Unknown
A-08*	582601	33º21'07"	103º58'26"	Unknown	Stock	Unknown	Unknown
A-09	RA-8588	33º16'00"	103º56'51"	Unknown	Unknown	Unknown	Unknown
A-10	RA-9320	33º23'42"	103º58'39"	Unknown	Unknown	Unknown	Unknown
A-11	RA-8577	33º24'41"	103º58'45"	Unknown	Unknown	Unknown	Unknown
A-12	RA-9670	33º28'45"	103º58'51"	Unknown	Unknown	Unknown	Unknown
A-13	Windsor Well	33º30'02"	103º57'12"	Unknown	Unknown	Unknown	Unknown
A-14	RA-9568	33º30'51"	103º55'00"	Unknown	Unknown	Unknown	Unknown
A-15	RA-8363	33º30'55"	103º53'06"	Unknown	Unknown	Unknown	Unknown
A-16	444901	33°24'33"	103°44'49"	119	OBS	Unknown	Unknown
A-17	473601	33°08'52"	103°47'36"	198	OBS	Unknown	Unknown
A-18	471901	32°59'12"	103°47'19"	331	OBS	Unknown	Unknown
A-19	393801	33°20'13"	103°39'38"	138	OBS	Unknown	Unknown
A-20	332801	33°19'43"	103°33'28"	69	OBS	Unknown	Unknown
A-21	145501	33°17'30"	103°14'55"	122	OBS	Unknown	Unknown
A-22	403301	33°21'24"	103°40'40"	110	OBS	Unknown	Unknown
A-23*	403501	33°23'48"	103°40'35"	95	OBS	Unknown	Unknown
A-24	373901	33°24'39"	103°37'39"	63	OBS	Unknown	Unknown

Table 3-4. (continued).

Well Name on Figures	USGS Well Identifier	Well Location		Well Depth (feet bgs)	Water Use	Average Pumping Rate (gpm)	Maximum Pumping Rate (gpm)
		Latitude	Longitude				
A-25	382001	33°21'50"	103°38'20"	80	OBS	Unknown	Unknown
A-26	483001	33°09'07"	103°48'30"	80	Stock	Unknown	Unknown
A-27	482701	33°09'08"	103°48'27"	Unknown	Stock	Unknown	Unknown
A-28	455501	33°10'07"	103°45'55"	Unknown	Stock	Unknown	Unknown
A-29	463301	33°11'51"	103°46'33"	Unknown	Unused	Unknown	Unknown
A-30	461801	33°12'22"	103°46'18"	Unknown	Industrial Cooling	Unknown	Unknown
A-31	460301	33°12'37"	103°46'03"	217	Irrigation	Unknown	Unknown
A-32*	465801	33°13'06"	103°46'58"	216	Irrigation	Unknown	Unknown
A-33	465701	33°13'16"	103°46'57"	196	Irrigation	Unknown	Unknown
A-34	475501	33°14'31"	103°47'55"	145	Unused	Unknown	Unknown
A-35	474601	33°14'44"	103°347'46"	166	Domestic	Unknown	Unknown
A-36*	491202	33°16'31"	103°49'12"	40	Domestic	Unknown	Unknown
A-37	L-5016	33°20'37"	103°47'55"	Unknown	Unknown	Unknown	Unknown
A-38	44241	33°19'28"	103°48'28"	Unknown	Unknown	Unknown	Unknown
A-39	L-11,326-S-2	33°19’53"	103°48’06"	Unknown	Unknown	Unknown	Unknown
A-40	L-11,326	33°19’44"	103°48’08"	160	Unknown	Unknown	42 gpm
A-41*	21113	33°19'28"	103°48'28"	Unknown	Unknown	Unknown	Unknown
A-42	RA-8576	33°19'23"	103°48'07"	Unknown	Unknown	Unknown	Unknown
A-43*	33442	33°19'43"	103°47'47"	Unknown	Abandoned	Unknown	Unknown
A-44*	33442a	33°19'42"	103°47'48"	Unknown	Abandoned	Unknown	Unknown
A-45*	122244	33°19'38"	103°47'33"	Unknown	Unknown	Unknown	Unknown
A-46	L-11,326-S	33°19’53"	103°48’06"	Unknown	Unknown	Unknown	Unknown

Legend:

bgs – below ground surface
gpm – gallons per minute
OBS – observation well
Stock – livestock water supply
* - Well listed in both Tables 3-4 and 3-5

Table 3-5. Characteristics of wells within 10 miles of the Roswell site (3-006).

Well Name on Figures	Location	Well Status	Altitude (feet)	Depth of well (feet below ground surface)	Depth to Water (feet below ground surface)	Aquifer	Date of Measurement
			Wells within 5-mile buffer-Chaves County				
B-08	11.31. 1.33333	Shot Hole	4,498.00	91	42.90	Ogallala	March 25, 1971
B-09	11.31.10.44141	Stock	4,469.10	–	45.79	Ogallala	February 8, 1966
B-10	11.31.11.11111	Shot Hole	4,490.20	–	40.11	Ogallala	April 14,1961
B-11	11.31.12.41414	Domestic	4,464.00	–	177.80	Ogallala	March 25, 1971
B-12	11.31.16.32433	Stock	4,474.00	–	141.32	Ogallala	March 26, 1971
B-13	11.31.16.34122	Stock	4,473.50	–	141.47	Ogallala	March 26, 1971
B-14	11.31.16.43224	Abandoned/Stock	4,458.70	–	82.65	Ogallala	March 26, 1971
B-15	11.31.21.144221	Stock	Unknown	–	111.67	Ogallala	April 2, 1971
B-16	11.31.21.44442	Stock	4,471.80	–	117.74	Ogallala	September 1, 1971
A-36*	11.31.21.44443	Abandoned	4,471.00	–	113.19	Ogallala	April 14, 1961
B-17	11.31.22.12232	Oil Test	4,470.30	–	118.72	Ogallala	April 14, 1961
B-18	11.31.22.13311	Uncased Shot Hole	4,474.90	–	111.02	Ogallala	April 14, 1961
B-19	11.31.23.33333	Unused, Unequipped	4,437.00	–	129.65	Ogallala	January 7, 1975
B-20	11.31.24.31131	Unknown	4,447.00	–	55.79	Ogallala	March 25, 1971
B-21	11.31.24.44444	Stock	4,437.50	–	56.20	Ogallala	March 24, 1971
A-43*	11.31.26.334332	Abandoned	4,453.25	–	76.60	Ogallala	March 23, 1971
A-44*	11.31.26.343	Abandoned	4,452.00	95.0	77.37	Ogallala	December 2, 1977
B-22	11.31.28.12133	Uncased Shot Hole	4,477.20	–	131.19	Ogallala	April 14, 1961
A-41*	11.31.34.21131	Cased Shot Hole	4,460.10	–	90.15	Ogallala	March 24, 1971
A-45*	11.31.35.12224	Cased Shot Hole	4,453.00	–	76.01	Ogallala	March 24, 1971
B-23	12.31. 3.22443	Domestic/Stock	4,456.10	–	90.68	Ogallala	March 31, 1971
B-63	11.32. 6.33333	Used windmill	4,472.00	–	46.40	Ogallala	March 25, 1971
B-64	11.32. 6.33334	Used windmill	4,472.00	–	38.58	Ogallala	March 25, 1971
B-65	11.32. 7.33333	Shot hole	4,458.00	–	25.67	Ogallala	April 14, 1961
B-66	11.32.19.12344	Used windmill	4,429.00	–	85.90	Ogallala	March 24, 1971

Table 3-5. (continued).

Well Name on Figures	Location	Well Status	Altitude (feet)	Depth of well (feet below ground surface)	Depth to Water (feet below ground surface)	Aquifer	Date of Measurement
Wells within 5-mile buffer-Lea County							
Wells between 5 and 10-mile buffers-Chaves County							
B-01	9.30.28.434	Stock	4,045.00	50.4	35.61		January 24,1978 (S.C. 1500, pumping)
B-02	9.31.36.34334	Stock	Unknown	149	131.70	Ogallala	April 29, 1971
B-03	10.29.10.222	Domestic	3,947.00	430	425		December 2,1977 (Yield.5 gpm)
B-24	10.31.25.32222	Stock	4,396.00	114	81.24	Ogallala	April 2, 1971
B-25	10.31.26.341434	Stock	4,382.00	–	172.01	Ogallala	April 2, 1971
B-26	10.31.35.121	Stock	4,387.00	55+	44.87		December 2, 1977
B-27	10.31.35.121431	Stock	4,385.00	119	45.76	Ogallala	November 6, 1969
B-28	10.31.35.112242	Stock	4,386.00	237	162.70	Ogallala	July 28, 1930(Destroyed)
B-04	10.31.36.21325	Stock	4,375.70	64	61.56	Ogallala	April 2, 1971
B-05	11.29.13.244	Abandoned	3,955.00	339.8	310.39		January 22, 1978
A-08*	11.30.19.131		3,863.00	127.3	107.33		January 22, 1978
A-05*	12.30.17.424	Stock	3,882.00	88.3	65.8		January 22, 1978 (S.C. 3800, pumping)
B-29	12.31. 1.41123	Stock	4,433.85	–	74.59	Ogallala	March 31, 1971
B-06	12.31.16.42121	Domestic	4,314.10	–	25.49	Ogallala	March 16, 1961
B-07	12.31.22.323	Stock	4,435.00	134.3	131.34	Ogallala	December 2, 1977
B-30	12.31.26.33321	Abandoned	4,423.48	–	132.78	Ogallala	March 30, 1971
B-31	12.31.26.33331	Unused water table well	4,423.50	145	131.74	Ogallala	January 7, 1975
B-32	12.31.26.333	Unused	Unknown	145	131.39	Ogallala	February 16, 1964
A-32*	13.31. 2.24442	Secondary recovery	4,394.00	–	139.07	Ogallala	February 14, 1966
B-33	10.32.17.12233	Stock	Unknown	–	52.70	Ogallala	April 1, 1971
B-34	10.32.18.43313	Stock	Unknown	–	37.85	Ogallala	April 1, 1971

Table 3-5. (continued).

Well Name on Figures	Location	Well Status	Altitude (feet)	Depth of well (feet below ground surface)	Depth to Water (feet below ground surface)	Aquifer	Date of Measurement
Wells between 5 and 10-mile buffers-Lea County							
B-35	10.32.20.32433	Stock	Unknown	–	64.13	Ogallala	April 1, 1971
B-36	10.32.20.34122	Domestic/stock	Unknown	89	66.50	Ogallala	August 7, 1930
B-37	10.32.29.113212	Open cased hole	Unknown	94	63.77	Ogallala	April 1, 1971
B-38	10.32.31.244132	Stock	Unknown	–	61.30	Ogallala	April 1, 1971
A-23*	10.32.33.34211	Stock	Unknown	–	54.84	Ogallala	April 1, 1971
B-39	11.32. 3.31414	Used windmill	Unknown	–	68.00	Ogallala	February 28, 1966
B-40	11.32. 3.33322	Open cased hole	4,384.00	105	63.40	Ogallala	March 23,1971
B-41	11.32. 8.22222	Used windmill	4,411.00	–	44.75	Ogallala	March 24,1971
B-42	11.32.12.32223	Used windmill	4,324.00	–	52.99	Ogallala	March 24,1971
B-43	11.32.13.23213	Used windmill	4,323.20	–	56.54	Ogallala	March 24,1971
B-44	11.32.14.33333	Used windmill	4,381.00	–	63.58	Ogallala	March 29,1971
B-45	11.32.15.11444	Used windmill	4,389.00	–	63.35	Ogallala	March 23,1971
B-46	11.32.21.1400	Used windmill	4,411.00	–	31.72	Ogallala	September 1, 1971
B-47	11.32.21.14000	Stock	4,411.00	–	32.93	Ogallala	March 24, 1971
B-48	11.32.28.2100	Used windmill	4,410.00	–	47.88	Ogallala	February 8, 1966
B-49	11.32.28.21000	Stock/Domestic	4,410.00	58	39.58	Ogallala	September 1, 1971
B-50	11.32.28.21133	Domestic	Unknown	56	41.50	Ogallala	September 1, 1971
B-51	11.32.30.24443	Used windmill	4,422.00	–	44.81	Ogallala	March 24, 1971
B-52	11.32.32.41234	Stock	Unknown	64	30.55	Ogallala	March 23,1971
B-53	11.32.33.33434	Shot Hole	4,401.00	–	30.49	Ogallala	February 14, 1966
B-54	11.32.36.23113	Used windmill	4,323.00	–	69.94	Ogallala	March 23,1971
B-55	12.32. 2.12212	Used windmill	4,353.00	–	49.28	Ogallala	February 9, 1966
B-56	12.32. 3.433	Used observation	Unknown	–	51.41	Ogallala	January 7, 1975
B-57	12.32. 4.42442	Used windmill	4,396.00	–	27.77	Ogallala	March 31,1971
B-58	12.32.15.34433	Used windmill	4,356.00	–	40.23	Ogallala	March 31,1971
B-59	12.32.16.14144	Used windmill	4,378.00	–	40.73	Ogallala	February 8, 1966
B-60	12.32.19.14444	Shot hole	4,394.00	–	79.02	Ogallala	March 30,1971
B-61	12.32.30.24444	Used windmill	4,380.00	–	100.01	Ogallala	March 30,1971
B-62	12.32.31.23332	Secondary Recovery	4,386.00	–	131.49	Ogallala	March 30,1971

* - Well listed in both Tables 3-4 and 3-5

Table 3-6. Information for well L-11,320 completed in Ogallala Aquifer (3-002, 3-011).

Well Name on Figures	Well Identifier	Well Location	Well Depth (feet bgs)	Water Use	Average Pumping Rate (gpm)	Maximum Pumping Rate (gpm)
A-40	L-11,326	11S 31E Section 27 SE ¼ SE ¼ SE ¼	160	Commercial, Industrial, or Irrigation	80 acre-feet per year (permitted amount) = 50 gpm	Estimated yield per driller's log 42 gpm

bgs = below ground surface
gpm = gallons per minute

3.2.2.3 Known Future Wells within 10 Miles of the Site

The term "known future well" is interpreted to mean a well for which a *Permit to Appropriate the Underground Waters of the State of New Mexico* has been granted, but the well itself has yet to be proved. The known future wells in the Ogallala Aquifer near the site are also shown on Figure 3-6. Two known future wells have been identified. Both of these wells are identified in permit L-11,320 granted to Robert W. Marley and Gandy Marley, Inc. for construction of three wells within 4 miles of the site. One well has been installed (see Table 3-6) and the other two are known future wells (see Table 3-7).

Table 3-7. Known future wells in the Ogallala Aquifer (3-002).

Well Name on Figures	Permit Number	Location	Permitted Depth (feet bgs)	Permitted Extraction Rate (gpm or acre-feet per year)	Permit Expiration Date, If Water is Not Applied to Beneficial Use
A-46	L-11,326-S	T11S, R31E Section 27	200	Total of 80 acre-feet per year for three wells (L-11,326; L-11,326-S; and L-11,326-S-2)	September 30, 2007
A-39	L-11,326-S-2	T11S, R31E Section 27	200	Total of 80 acre-feet per year for three wells (L-11,326; L-11,326-S; and L-11,326-S-2)	September 30, 2007

bgs = below ground surface
gpm = gallons per minute

3.2.2.4 Existing Ogallala Aquifer Potentiometric Conditions

Only small amounts of ground water can be produced from the Dockum Formation at the site itself, and consequently no wells have been constructed at the site nor are any anticipated to be installed. Due to the lack of existing or anticipated wells, potentiometric conditions in the Triassic sediments that underlie the site are not discussed here.

Although the exact locations of production wells for GNEP facilities have yet to be determined, it is reasonable to assume that the production wells will be located in the Ogallala Aquifer within a few miles of the site. Hence, potentiometric conditions in the Ogallala aquifer are relevant to the site even though the Ogallala aquifer is not present at the site itself. Ground water in the Ogallala Aquifer near the site occurs under water table conditions. As discussed in Section 3.2.1.3 and shown on Figure 3-8, the water table (potentiometric surface) slopes down in the southeasterly direction. Water level data used to prepare this map were obtained from a USGS database (3-007). The regional hydraulic gradient is approximately 10 to 15 feet per mile (3-038)

3.2.2.5 Effect of Offsite Pumping

To evaluate the potential for ground water extraction for site operations to affect other water users, and the potential for other users to affect the water supply for GNEP facilities, it is assumed that the Ogallala is the aquifer of primary interest.

Numerous wells are located near Roswell in a shallow alluvial aquifer near the Pecos River, and in limestones and dolomites at greater depth. As a result of the great distance between these wells and the site, and the low hydraulic conductivity of the formations that lie stratigraphically between the Ogallala Formation and the geologic units that host the aquifers near the City of Roswell (see Section 9.2), ground water extraction from the Ogallala Aquifer to supply water for GNEP facility operations will not affect water levels or water availability in the aquifers near the City of Roswell. Similarly, neither existing nor future wells in aquifers near the City of Roswell are likely to affect production of ground water from the Ogallala aquifer.

The location of production wells that will supply GNEP facilities and the ground water extraction rate will be determined during the facility design phase. Without a known well location and extraction rate, detailed predictions of the effect of pumping potential GNEP supply wells on nearby wells and the effect of other water supply wells on potential GNEP supply wells cannot be made. Nevertheless, general predictions can be made based on the assumption that water supply wells for GNEP facilities will be constructed in the Ogallala aquifer within a few miles of the site. Based on this assumption, drawdown calculations were made based on hydraulic properties of the Ogallala Aquifer in that area and a selected range of pumping rates. These drawdown estimates can be used to estimate both the effect of potential GNEP water supply wells on nearby wells in the Ogallala aquifer, and the effect of nearby Ogallala aquifer wells on potential GNEP water supply wells. The approach for calculating drawdown, the data used in these calculations, and the estimated drawdown for various pumping rates are presented in Section 3.2.2.6.

The achievable pumping rate for wells completed in the Ogallala Aquifer is expected to be greater than 100 gpm (Figure 3-4). However, the maximum allowable pumping rate is likely to be constrained by administrative limits on aquifer depletion rather than the hydraulic properties of the aquifer. The Hydrology Bureau of the NMOSE recommends that pumping wells not produce more than 1 foot of water level decline in 40 years in the portion of the Ogallala Aquifer near the Mescalero Ridge escarpment and Mescalero Point (3-004).

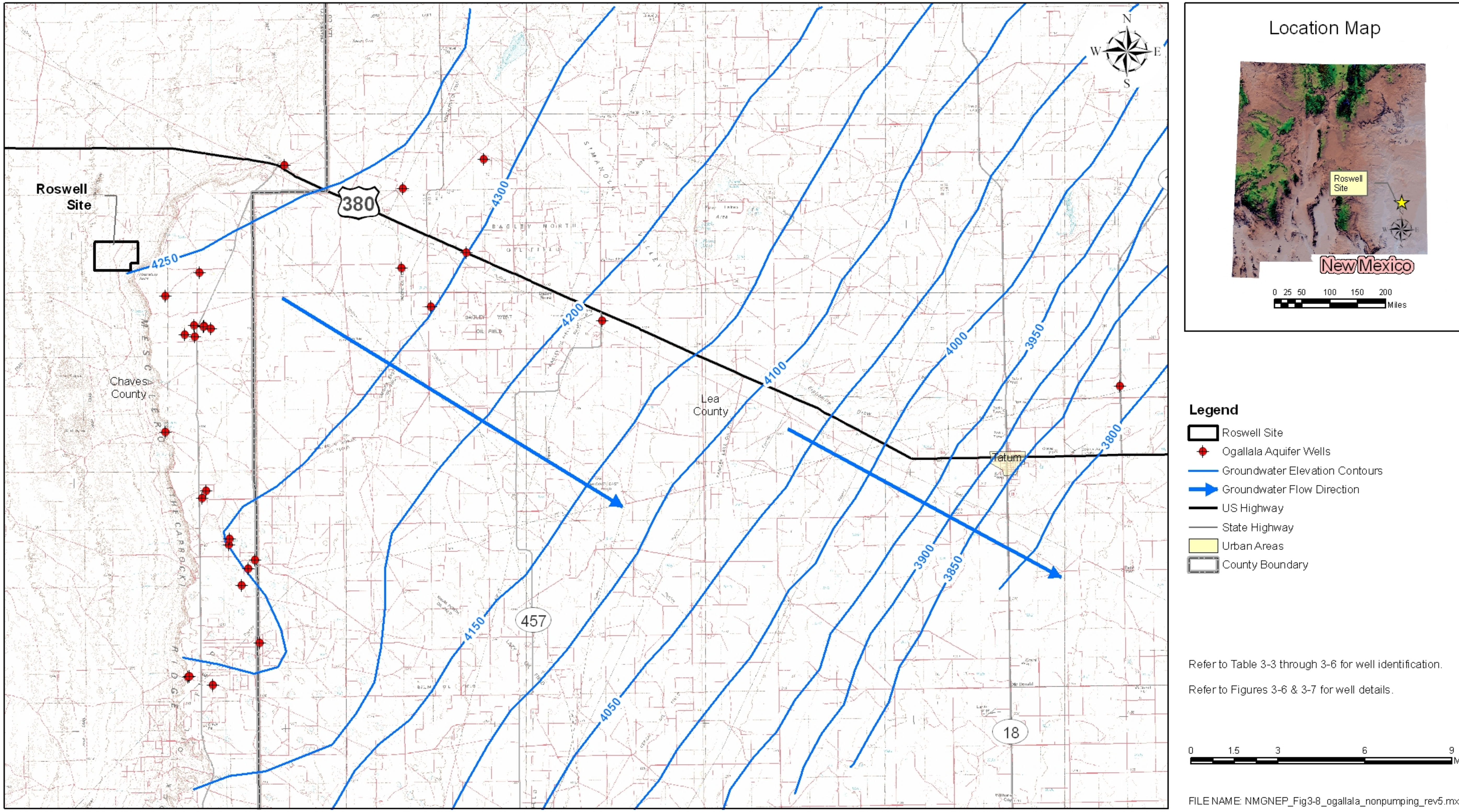

Figure 3-8. Potentiometric conditions in Ogallala Aquifer (2000-2006 data) (3-018, 3-020, 3-023, 3-024).

During the evaluation of the Gandy Marley water right application for three proposed production wells to be located approximately 2 miles southeast of Mescalero Point (permit application # L11,326) the Hydrology Bureau found that a combined pumping rate of 426 acre-feet per year (264 gpm) would be likely to dewater the portion of the aquifer nearest the pumping wells (i.e., in the 1 mile square grid block of the numerical ground water flow model used for simulating ground water flow) in less than 40 years if none of the pumped water were returned to the aquifer as ground water recharge (3-004). Gandy Marley's consultant found that if the net pumping rate were reduced to 355 acre-feet per year (220 gpm), then 32.84 feet of saturated aquifer would remain near the pumping wells after 40 years (3-003). The water level decline estimates presented by both the Hydrology Bureau and the consultant were produced using the Lea County Ground Water Flow Model. The model is well calibrated and is used by the NMOSE to evaluate water rights applications in the Ogallala Aquifer in the Lea County UWB (3-004).

3.2.2.6 Estimated Drawdown Due to Ground Water Pumping

The drawdown expected to occur near a well that pumps ground water from the Ogallala Aquifer was calculated using the Thiem analytical solution, which is based on the assumption of steady state, radial flow in a homogeneous, isotropic, unconfined (i.e., water table) aquifer of uniform saturated thickness under nonpumping conditions. These assumptions are reasonable for the conditions that exist in the Ogallala Aquifer in the site vicinity at the scale of the predicted drawdown cones.

Approach

The Thiem solution for an unconfined aquifer is typically described as (3-041):

$$K = \frac{Q}{\pi(h_2^2 - h_1^2)} \ln\left(\frac{r_2}{r_1}\right) \qquad (1)$$

where:

K is the hydraulic conductivity [L]

Q is the discharge rate in the pumping well [L^3 T^{-1}]

h_1 is the saturated thickness of the aquifer within the drawdown cone at distance r_1 from the pumping well [L]

h_2 is the saturated thickness of the aquifer at distance r_2 from the pumping well [L].

This equation can be solved for the change in hydraulic head between any two radial distances from the pumping well. If r_2 and h_2 are held constant at the radius of influence of the pumping well while r_1 is varied, h_1 can be calculated at varying distances from the well. Drawdown at each radial distance is calculated as the difference between the saturated thickness of the aquifer under nonpumping conditions (which is equal to h_2 at the radius of influence of the pumping well) and h_1 at each r_1.

The cone of depression resulting from pumpage of any well will continue to grow until either the volume of water pumped from the well is balanced by ground water recharge inside the cone or a recharge boundary, such as a river that is hydraulically connected to the aquifer, is reached. In the case of the site, recharge from infiltration of precipitation is the only recharge source considered. It is assumed that none of the water extracted from the aquifer will subsequently recharge the Ogallala Aquifer.

In the case of diffuse spatial recharge from infiltration of precipitation, the diameter of a cone of depression (the radius of influence) is controlled by two variables: the pumping rate and the net infiltration (i.e., recharge) rate. The linkage between pumping rate, recharge rate, and size of a drawdown cone is that the water pumped from a well is extracted only from the part of the aquifer inside the drawdown cone. In order for the assumption of steady state conditions to be valid, the volume of water pumped out of the aquifer in a given time period must be replaced by an equivalent volume of water that recharges the aquifer in that time period. The volume of recharge per unit time is the product of the recharge rate (volume of water per unit area per unit time) and the area through which recharge is occurring. Hence, if the pumping rate and recharge rate are known, the area of the recharge zone can be easily calculated. The recharge zone is a circle that has the same radius as the drawdown cone.

The following equation describes the relationship between pumping and recharge flowrates, the net infiltration rate, and the size of the recharge area (drawdown cone):

$$Q_p = Q_R = \pi r_i^2 I \tag{2}$$

where:

Q_p is the pumping rate from the well [$L^3 T^{-1}$]

Q_R is the recharge rate into the aquifer in a circular area with radius r_i centered at the pumping well [$L^3 T^{-1}$]

r_i is the radius of the recharge zone and the cone of depression; it is also known as the radius of influence of the well [L]

πr^2 is the surface area of the cone of depression with radius r_I [L^2]

I is the one dimensional recharge rate from precipitation [L/T].

Solving equation (2) for the radius of the cone of depression yields the following:

$$r_i = \sqrt{\frac{Q_p}{\pi I}} \tag{3}$$

Equation 3 shows that for a given recharge rate, a greater pumping rate produces a larger cone of depression, and hence the effects of pumping extend farther from the pumping well.

The aquifer property values needed to calculate drawdown and the sources of these values are summarized below (Table 3-8). Values in imperial units were converted into metric units to facilitate calculation; the corresponding values in metric units are also shown.

The four values of pumping rate were selected, 40 acre-feet per year, 80 acre-feet per year, 100 acre-feet per year, and 120 acre-feet per year, bracket the withdrawal rate in a recently granted permit (L11,326) that allows Gandy Marley, Inc. to pump water from the Ogallala Aquifer in an area where production wells for the Roswell facilities might be constructed. Bracketing the permitted withdrawal rate allows the effect of lower pumping rate as a result of splitting a water right between two wells (40 acre-feet per year) to be evaluated. Higher flowrates (>80 acre-feet per year) account for pumping for only part of the year (typical for irrigation wells), and pumping from a well where a larger withdrawal rate is permitted.

Table 3-8. Values used to calculate drawdown near hypothetical well completed in Ogallala Aquifer.

Property	Referenced Value	Values Used in Calculations
Recharge from precipitation	1 inch/year (3-038)	6.96×10^{-5} meters per day
Pumping rates:		
Q_1	40 acre-feet/year (50 percent water right)	135 cubic meters per day
Q_2	80 acre-feet/year (permitted water right allowed diversion; 3-002)	270 cubic meters per day
Q_3	100 acre-feet/year (125 percent water right)	335 cubic meters per day
Q_4	120 acre-feet/year (150 percent water right)	406 cubic meters per day
Radius of influence	Calculated values (3-041)	
r_i for Q_1	2,578 feet	786 meters
r_i for Q_2	3.641 feet	1,110 meters
r_i for Q_3	4,067 feet	1,240 meters
r_i for Q_4	4, 461 feet	1,360 meters
Hydraulic conductivity (K)	4 feet/day (3-004)	1.22 meters per day
Aquifer thickness (h_2)	70.2 feet (3-004)	21.4 meters

Results

The results of drawdown calculations for four pumping rates are shown in Table 3-9. Drawdown values for four pumping rates are shown in different columns, and values in different rows are for different radial distances from the well. The variable spacing in Table 3-9 was selected based on the general shape of a drawdown curve. The amount of drawdown is greatest at the well, and the rate of change in drawdown with distance from the well is greatest near the well. Both the magnitude and rate of change of drawdown decrease markedly with increasing distance from a well. Blank values in the cells of Table 3-9 represent combinations of distance and pumping rate that yield calculated drawdown values that are larger than the saturated thickness of the aquifer (i.e., this mathematical solution would predict that the aquifer could not support the assumed pumping rate). Calculated drawdown values that exceed the saturated thickness of the aquifer also appear in tables of predicted drawdown presented in an attachment to the application for permit L11, 326 (3-004).

Drawdown curves for these four pumping rates (Figure 3-9) are graphed with the drawdown values increasing in the down direction on the Y-axis so that the drawdown curves have the same orientation as the water table (i.e., the water table is lowest at the well and becomes higher at greater distance from the well). These drawdown curves show three characteristic features. First, drawdown values are greatest at the well and decrease with increasing distance. Second, at a given distance, drawdown is greater for larger pumping rates. Third, the radius of influence (i.e., the distance required for drawdown to decline to zero) increases with increasing pumping rate.

Table 3-9. Drawdown as a function of pumping rate and distance from production well.

Distance From Well (feet)	Pumping Rate (acre-feet per year) 40	80	100	120
	Drawdown (feet)			
1	26.1	–	–	–
2	23.2	–	–	–
5	19.6	–	–	–
10	17.1	49.1	–	–
20	14.7	39.0	–	–
50	11.6	29.3	42.8	–
100	9.4	23.3	32.7	45.7
200	7.3	18.0	24.8	32.9
500	4.6	11.7	16.0	20.9
1,000	2.6	7.4	10.3	13.4
2,000	0.7	3.3	5.0	6.9
3,000	0.0	1.1	2.1	3.3
4,000	0.0	0.0	0.1	0.9
5,000	0.0	0.0	0.0	0.0

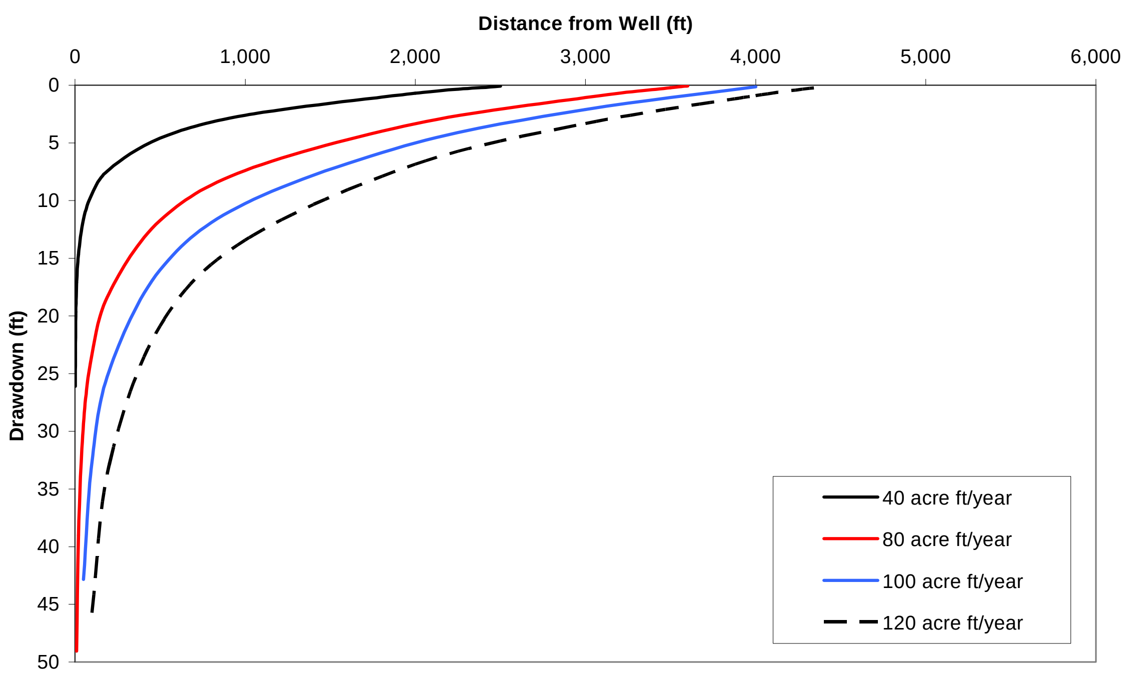

Figure 3-9. Plot of drawdown as a function of pumping rate and distance from production well (3-028, 3-029).

Contours of equal drawdown are shown for three pumping rates (40 acre-feet per year, 80 acre-feet per year, and 120 acre-feet per year) to illustrate the extent of the drawdown cone (Figure 3-10). The drawdown cones are centered at the location of the first well identified in permit L-11,326. The drawdown cone delineated by the 0.1 feet drawdown contour generated by a well pumping 80 acre-feet per year is predicted to extend less than 3,600 feet.

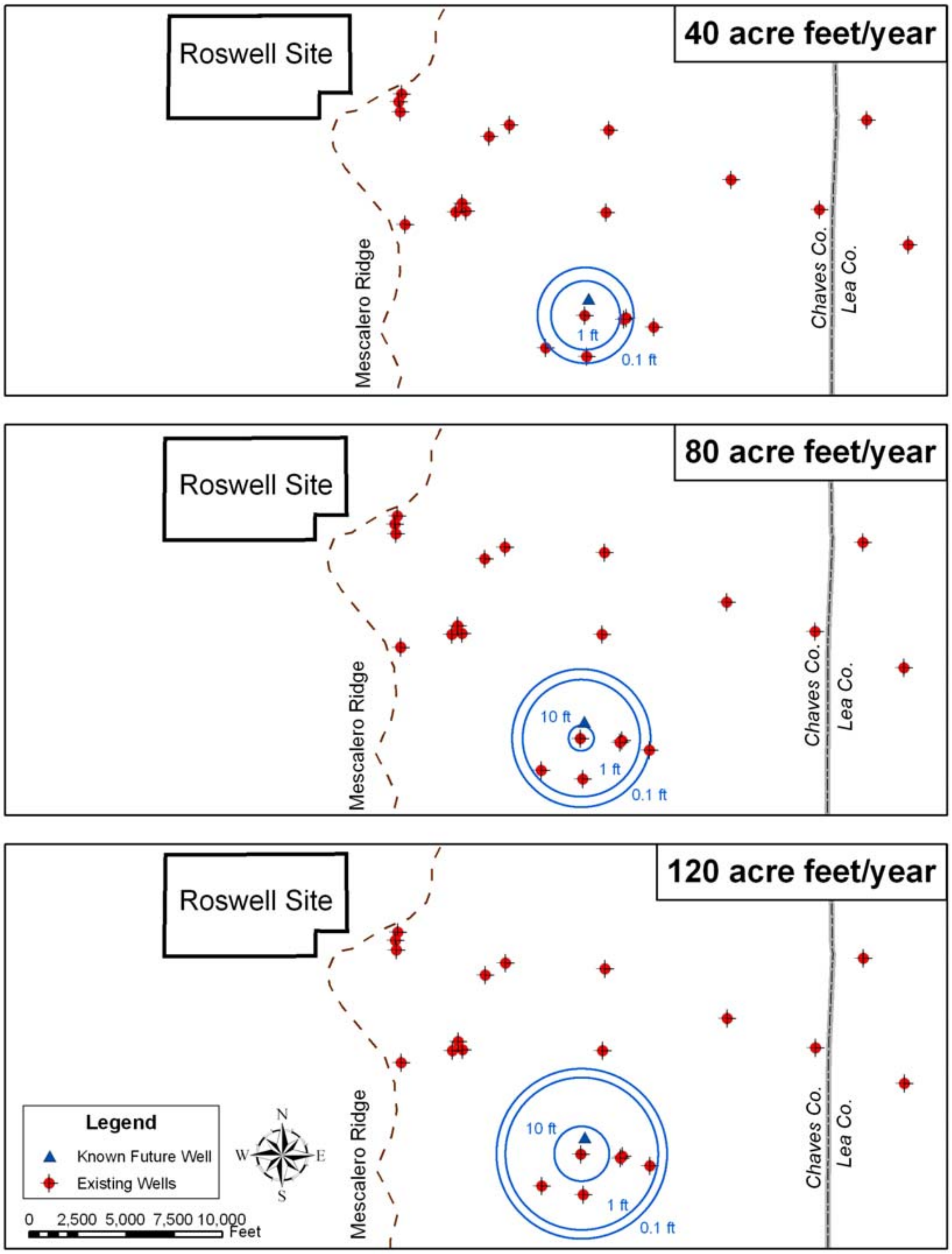

Figure 3-10. Map showing contours of equal drawdown for three pumping rates (3-028, 3-029, 3-030, 3-031, 3-032, 3-033, 3-034).

3.2.3 Ground Water Quality

Ground water is present beneath the site, although only small yields are likely to be available. This section describes federal and state classification systems for ground water, identifies the underlying aquifers, compares available water quality data to the classification criteria, and finally identifies the classification category for ground water beneath the site.

3.2.3.1 Classification Criteria

The EPA classification system for ground water (3-005) is summarized in Table 3-10. The Classification Review Area is delineated based initially on a 2-mile radius from the boundaries of the facility or activity (3-005).

Ground water in New Mexico with TDS concentrations of 10,000 milligrams per liter or less is subject to protection (NMAC 20.6.2.3103) and must be remediated if contaminated (3-042).

Both the EPA and the State of New Mexico consider ground water with TDS of 10,000 milligrams per liter or less to be a usable resource.

Table 3-10. EPA ground water classification system (3-005).

Class	Subclass	Description and Criteria
I		Highly vulnerable, and either irreplaceable to substantial populations, or ecologically vital.
II	IIA	Current source of drinking water.
	IIB	Potential source of drinking water. TDS < 10,000 milligrams per liter and capable of producing 150 gpd.
III	IIIA	Not a source of drinking water due to intermediate to high aquifer interconnection, and >10,000 milligrams per liter TDS or untreatable, OR Not a source of drinking water due to insufficient yield (<150 gpd).
	IIIB	Not a source of drinking water-low aquifer interconnection, and >10,000 milligrams per liter TDS or untreatable.

3.2.3.2 Observed Water Quality and Ground Water Classification

Ground water occurs near the site as shallow, perched water bodies in the Upper Dockum unit, but ground water was not detected in the Upper Dockum within the boundaries during site characterization studies performed for the Triassic Park HWDF permit application (3-038). Ground water was present in a sandstone layer (termed the Santa Rosa Equivalent) in the Lower Dockum unit in wells within 1 mile of the site during Triassic Park site characterization studies, but no onsite boreholes extended deep enough to encounter that unit. Therefore, information about water quality and potential yield from wells is drawn from wells in the vicinity of the site, but not from within the site boundary.

Information about wells in the vicinity of the site is summarized in Table 3-11. Wells are categorized as being less than 2 miles or greater than 2 miles from the site, based on EPA's Classification Review Area size (3-005)

Table 3-11. Water quality in wells near the Roswell site.

Well	Distance from Site (miles)	Depth (feet bgs)	TDS (milligrams per liter)
		Upper Dockum	
PB-14	<2[a]	100[c]	4,920[a]
MW-1	<2[b]	203[b]	8,930[b]
MW-2	<2[b]	180[b]	8,970[b]
Windsor	>2[a]	14[a]	14,000[a]
Beadle	>2[a]	258[a]	38,400[a]
		Lower Dockum	
WW-2	<2[c]	710[c]	18,800[c]
RA-8577	>2[a]	614[a]	Potable[a]
RA-9320	>2[a]	560[a]	Non-potable[a]
RA-9670	>2[a]	587[a]	Potable[a]

a (3-038)
b (3-010)
c (3-035)

Upper Dockum

Water quality data for three wells within 2 miles of the site, which were completed in the Upper Dockum Formation, all show TDS values below 10,000 milligrams per liter. Well yield was not measured at PB-14, which is interpreted to be completed in a perched water zone of small areal extent. Well yields of 154 and 206 gpd were measured in wells MW-1 and MW-2, respectively. Based on comparison to EPA criteria, ground water in the Upper Dockum Formation in the immediate vicinity of the site would be classified as Potential Source of Drinking Water (Class II B), and must be protected pursuant to State of New Mexico requirements.

Several wells are completed at depths of less than 100 feet bgs within 10 miles of the site and provide water for livestock and wildlife (Figure 3-3 and Table 3-2). Although neither measured TDS value nor well yield data have been identified for these wells, it is reasonable to assume that these wells produce sufficient quantities of potable water that ground water in the vicinity of those wells would also be classified as a Potential Source of Drinking Water, and would have TDS values that are sufficiently low that it would be protected by State requirements.

In contrast, TDS values reported for two wells (Windsor and Beadle wells) located about 10 to 12 miles from the site are above the 10,000 milligrams per liter TDS criteria used by both EPA and the State of New Mexico (Table 3-11). Ground water at those locations would be classified as Class III B - Not a Source of Drinking Water under the EPA classification system, and would not require protection or remediation pursuant to New Mexico requirements.

Even though ground water more than 2 miles from the site may not be considered to be a potential source of drinking water, Upper Dockum formation ground water in the immediate vicinity must be considered as a resource that requires protection, even though the formation apparently yields only small quantities of fairly low quality ground water.

Lower Dockum

Only one well (WW-2) within 2 miles of the site both extended deep enough to produce water from the Lower Dockum Formation, and yielded a representative sample for water quality analysis. The TDS value of 18,800 milligrams per liter is far above the EPA and State criterion of 10,000 milligrams per liter, and hence the Lower Dockum formation in the immediate vicinity of the site would be classified as III B – Not a Potential Source of Drinking Water under the EPA classification system, and it would not require protection or remediation under New Mexico requirements.

Anecdotal evidence for three wells between 2 to 10 miles from the site suggests that water quality is spatially variable. One well was reported to have been plugged and abandoned because it produced non-potable water, although analytical results were not reported. Two other wells were reported to produce between 2 and 6 gpm, and there was no report that they had been plugged and abandoned. Hence, it is reasonable to infer that they produced potable water, and furthermore that the Lower Dockum formation more than 2 miles from the site may be a potential source of drinking water.

3.2.4 Existing Contamination with Actual or Potential Effect on Ground Water Quality

If existing environmental contamination were to degrade water quality in the aquifer utilized as a water supply for Roswell facilities, this degradation could interfere with facility operations.

The Ogallala Aquifer lies stratigraphically above the Triassic formation that underlies the site and is topographically above the site as well (Figure 3-2). The elevation of the water table in the Ogallala Aquifer near the site is higher than the ground surface elevation at the site. As a result of this configuration, the Ogallala Aquifer is not vulnerable to contamination from contaminant sources west of Mescalero Ridge.

Hence, only contaminant sources east of Mescalero Ridge could potentially degrade water quality in the Ogallala Aquifer. The majority of surface use within the Lea County UWB is ranching and farming, which are typically not major point sources of groundwater contamination. Numerous stock wells exist within the basin, as well as irrigation wells and wells for municipal supply. There is no known source of existing environmental contamination with impacts or potential impacts to ground water quality.

There is a surface waste management facility, permitted by the New Mexico Oil Conservation Division and owned by Gandy Marley, Inc., located within 1 mile of the site (3-010). This facility is located west of the Mescalero Ridge. As described earlier in this section, the topographic and hydrologic conditions of this locale would not allow migration of contaminants from the vicinity of the facility into ground water in the Ogallala Aquifer.

3.3 Surface Water Resources

As discussed in Section 1, Maps; Section 2, Aquatic and Riparian Ecological Communities; and Section 11, Hydrology/Flooding, there are no natural perennial surface water features within about 30 miles of the site. The sections below provide a brief summary of lack of surface water resources at the site.

3.3.1 Surface Water Systems

There are no perennial surface water bodies present at or near the site. The closest significant body of perennial surface water, the Pecos River, is located about 35 miles from the site and there are no perennial surface water drainages that connect the site to the river. A man-made surface water body at the site, Red Tank, is a stock pond that is supplied by a water pipeline from an offsite source. Other nearby surface water features are ephemeral and/or isolated features in closed depressions. The occasional ephemeral pools of water do not support aquatic habitat (see Section 2, Aquatic and Riparian Ecological Communities).

3.3.2 Surface Water Quantity

The only surface water present in the vicinity of the site is runoff from precipitation or snowmelt. Runoff has been sufficient to create gullies on Mescalero Ridge. However gullies disappear and water quickly infiltrates as the topographic slope flattens (see more detailed description in Section 11, Hydrology/Flooding). The site is located in the arid eastern ranchland of New Mexico where annual potential evaporation of up to 110 inches so greatly exceeds average annual precipitation of 13 to 16 inches that perennial surface water simply does not exist (see Section 10, Weather/Climatology, for detailed description).

3.3.3 Surface Water Quality

There are no natural perennial surface water features in the vicinity of the site. In the absence of surface water, it is evident that surface water quality cannot be affected by potential discharges from GNEP facilities.

The perennial stream closest to the site, the Pecos River, is about 35 miles west of the site. No well defined drainage channels or arroyos lead from the site to the Pecos River or its tributaries. Given the large distance from perennial surface water and the absence of well defined surface water flow paths, it is unlikely that any water from operations at the site will be discharged to surface water, and hence it is unlikely that site operations will have any effect on surface water quality.

The great distance between the site and the Pecos River, and the availability of nearby groundwater as a potential water supply will likely result in surface water not being utilized as a water supply for operations at the site. Sources of contamination that may affect water quality in the Pecos River are unlikely to affect the water supply for facilities at the site, and therefore are not considered here.

The surface waste management disposal facility, located about 1 mile north of the site, does not discharge liquid effluent to either surface water or ground water, and therefore it is not a potential source of contaminants that could impair surface water quality.

3.3.4 Potentially Affected Wetlands

Extraction of ground water from the Ogallala Aquifer will not affect any aquatic or riparian communities within or near the site. As described in greater detail in Section 2, Aquatic and Riparian Ecological Communities, there are no wetlands under jurisdiction of the USACE at or near the site. There are a number of scattered ephemeral ponds southeast of the site and east of Mescalero Ridge, but few of these support wetland vegetation and none will be impacted by consumptive water use associated with the GNEP facilities. There are also several small springs that originate along Mescalero Ridge east of the site. Streams that emanate from these springs extend only a short distance and none cross the site. None of the springs near the project site support wetland vegetation or aquatic communities.

3.4 Ground Water Availability

As described in detail above, there is not an abundant source of high quality ground water available beneath the site for beneficial use, either for agricultural use or to support GNEP facility construction and operations. A likely source of ground water for GNEP construction and operations is the Ogallala aquifer, approximately 3.5 miles from the site. The sections below identify specific details of existing ground water availability from the Ogallala aquifer and the process that would be used to increase the available volume of water should that become necessary.

3.4.1 Ground Water Availability

Ground water is available for the site via water rights owned by Gandy Marley, Inc. and Robert W. Marley. Well L-11,326, located in Section 27, Township 11 South, Range 31 East, is approximately 3.5 miles from the site. Water from this well could be piped to the site location. Depending upon the amount of water needed, additional water and additional water rights can be obtained through the market process, and transferred to either the existing well or to other wells, for delivery to the site. In addition, an application could be filed to increase the amount of water rights in the existing well.

3.4.2 Water Rights

An active water rights market exists in New Mexico, and varies depending upon the supply and demand in each respective recognized basin. Water rights sales and transfers are not uncommon within the Lea County UWB. The Lea County Regional Water Plan (3-001, 3-046) indicates that in the Basin, as of 2000, there were 8,809 wells with a total of 492,770 acre-feet of water rights. These include declared, licensed, permitted, pending license, municipal and self-supplied domestic and stock wells. The non-irrigation water rights of municipalities accounted for combined water rights of 134,382 acre-feet from 801 wells. Domestic use was 16,263 acre-feet from 5,421 wells, and stock was 1,923 acre-feet from 641 wells.

If additional water rights are required to operate GNEP facilities, the best prospect for purchasing water rights would likely be from irrigation users. The Water Plan indicated 1,946 wells for 113,400 irrigated acres in the Lea County UWB with 340,202 acre-feet of water rights (declared, licensed, currently-permitted and pending licenses). Once water rights are obtained, the water rights might be transferable to the Gandy Marley, Inc. existing well, permitted under L-11,326. Transfers are conducted under procedures set forth in Chapter 72 of the New Mexico Statutes Annotated. In addition to the statutory procedures, the NMOSE utilizes an administrative block system for appropriations and transfers of water rights within the Lea County UWB. This block system is based on each respective individual township. The records of the NMOSE indicate that as of September 26, 2005, there were 355 acre-feet of water available for new appropriation in the administrative block (Township 11 South, Range 31 East) encompassing the site. The Lea County Water Users Association had filed an application to appropriate this available water, but it had not advertised the Notice of Publication as of that date.

The transfer from any non-commercial or non-industrial use water right (i.e., from irrigation) would be considered a change in purpose, and any transfer would be a change in place of use. The appropriate application must be filed with the NMOSE, and would be subject to protest in accordance with the requirements set forth in the statutes. Additionally, due to the administrative block restrictions that may be required by the NMOSE, water rights may be obtained for the Roswell facility, but a well to supply the water may have to be located in a neighboring township, increasing the distance that water must be pumped to the site.

As applied for, the Gandy Marley, Inc.'s permitted well has a 13 3/8-inch outside diameter casing, with an expected appropriation of 355 acre-feet per year consumptive use and 426 acre-feet per year depletion. The permitted well location is in the southeast quarter of Section 11, Township 11 South, Range 31 East. The site is located in Sections 17 and 18, Township 11 South, Range 3 East. The options to supply water to the site from the well would be either direct pumping from the existing well (approximately 3.5 miles) or filing an application with the NMOSE for a change in well location, transferring any existing (and obtained) water rights to a newly drilled location.

The NMOSE records were searched to identify existing water rights and additional water available for appropriation in the site vicinity. The site is located in Township 11 South, Range 31 East. Records were searched for Townships 10 through 12 South, Ranges 29 through 32 East. The results of this search (Table 3-12) indicate that over 3,000 acre-feet per year is available for appropriation from the Ogallala Aquifer in townships near the site. The water available for appropriation in each township is illustrated on Figure 3-11.

3.4.2.1 Existing Rights

On May 13, 2002, Robert Marley and Gandy Marley, Inc. filed an application with the NMOSE for 355.0 acre-feet per year (consumptive use) of water (426.0 acre-feet per year depletion), to be drawn from three wells within Section 27, Township 11 South, Range 31 East. After protest and hearing, the NMOSE approved the application for well No. L-11,326 for 80.00 acre-feet per year (3-002). The permit as approved allows for three wells within Section 27, Township 11 South, Range 31 East, with up to 80 acre-feet per year consumptive irrigation requirement, with the depth of the wells not to exceed the thickness of the Ogallala formation.

3.4.2.2 Known Future Rights

There are no known future ground water rights appurtenant to the site. There are no known Native American Tribal water rights that would be affected. There are no known existing permits that will expire, providing available water rights.

Table 3-12. Summary of water rights in Townships 10-12 South, Ranges 29-32 East.

Water Rights Summary
T 10-12 S, R 29-32 E, N.M.P.M.

OSE File Number	Use	Status	Section	Acres	Diversion (ac-ft)	Reserved (ac-ft)
T10S, R29E						
RA-8577	STK	DCL	34	---	3	---
RA-10572	DOM & STK	DCL	23	---	3	---
T10S, R30E						
None						
T10S, R31E						
RA-9482	STK	DCL	25	---	3	---
RA-9483	STK	DCL	23	---	3	---
RA-10567	STK	DCL	3	---	3	---
RA-10568	STK	DCL	10	---	10	---
RA-10571	STK	DCL	10	---	3	---
RA-10574	DOM & STK	DCL	35	---	3	---
RA-10577	STK	DCL	35	---	3	---
T10S, R32E						
RA-9484 thru RA-9486	DOM, STK & IRR	DCL	20	1	9	---
RA-9487	STK	DCL	18	---	3	---
RA-9488	STK	DCL	17	---	3	---
RA-10569	STK	DCL	8	---	3	---
T11S, R29E						
RA-9320	STK	DCL	1	---	3	---
T11S, R30E						
RA-8589	STK	DCL	19	---	3	---
T11S, R31E - 275 ac-ft available						
RA-8576	STK	DCL	34	---	3	---
L-11326 et al	COM & IND	PMT	27	---	80	80
T11S, R32E - 230 ac-ft available						
L-215	IRR	DCL	24	150	450	375
L-278	IRR	DCL	25	128.7	386.1	322
L-215-E	IRR	LIC	24	29.6	88.8	74
L-215-E	IRR	LIC	24	6.2	18.6	16
L-6273	COM	LIC	13	---	10	10
L-9615 et al	SRO	PMT	24	---	1030	1030
L-10881	IRR	PBU	3	58.97	176.91	147
L-10881-Enlg	IRR	APP	3	30	90	75
L-11027	IRR	PBU	10	130.38	391.14	326

Table 3-12. (continued).

Water Rights Summary
T 10-12 S, R 29-32 E, N.M.P.M.

OSE File Number	Use	Status	Section	Acres	Diversion (ac-ft)	Reserved (ac-ft)
T12S, R29E						
RA-8578	STK	DCL	29	---	3	---
RA-8579	STK	DCL	16	---	3	---
RA-8580	STK	DCL	9	---	3	---
RA-8581	STK	DCL	3	---	3	---
RA-8582	STK	DCL	27	---	3	---
RA-8583	STK	DCL	34	---	3	---
RA-8584	STK	DCL	24	---	3	---
T12S, R30E						
RA-8302	STK	DCL	3	---	4	---
RA-8585	STK	DCL	2	---	3	---
RA-8586	STK	DCL	3	---	3	---
RA-8587	STK	DCL	4	---	3	---
RA-8588	STK	DCL	17	---	3	---
RA-11023	IRR & STK	DCL	11	1	3	---
T12S, R31E - 905 ac-ft available						
RA-8575	DOM & STK	DCL	3	---	3	---
L-10141	SRO	PMT	25	---	---	170
T12S, R32E - 1,752 ac-ft available						
L-3322	SRO	PBU	31	---	157	157
L-3323	SRO	PBU	31	---	165.86	166

Uses:
SRO = Secondary recovery of oil
IRR = Irrigation
DOM = Domestic
STK = Livestock watering
COM = Commercial
IND = Industrial

Status:
DCL = Declaration
PMT = Permitted
APP = Applied for
PBU = Proof of Beneficial Use
LIC = Licensed

Available water is based on Lea County Underground Water Basin availability sheets where said basin falls within the respective townships. Within the Roswell Artesian Underground Water Basin, there is no water available for appropriation.

This summary does not include domestic/stock permits authorized under NMSA 72-12-1

Amount of acres are specified for irrigation rights.

Reserved refers to a water right's depletion amount reserved on a township's availability sheet, and is only applicable to water rights within the Lea County Underground Water Basin.

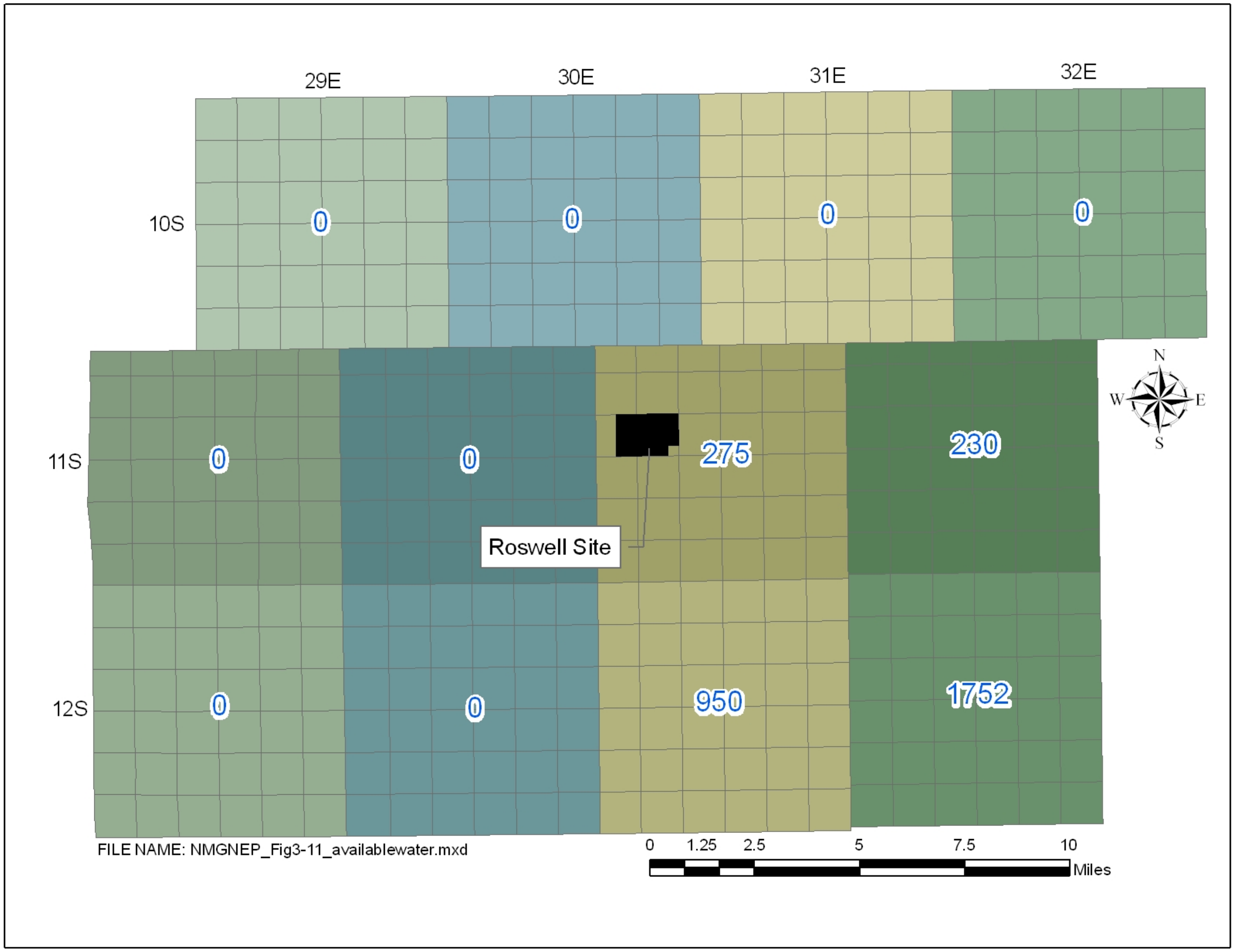

Figure 3-11. Water available for appropriation in townships near the Roswell site, in acre-feet per year (3-046).

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CONTENTS

FIGURES

TABLES

4. CRITICAL AND IMPORTANT TERRESTRIAL HABITATS

This section describes critical and important terrestrial habitats that occur within the Roswell site that have the potential to be disturbed by construction and operation of the GNEP facilities. Because the distribution of vegetation communities, and hence animal communities, is partly determined by climate and underlying soil properties, these resources are also briefly described for the Roswell site. More detailed climatology data are presented in Section 10, Weather/Climatology, and geological characteristics of the Roswell site are discussed in Section 9, Geology/Seismology. The dominant plant communities present at the site and the animals that are likely to use those communities are described in this section. Special status species (i.e., species covered under the ESA or of special concern to other federal, state, or local agencies) are discussed in Section 5, Threatened or Endangered and Special Concern Species.

4.1 Overview and Summary

The proposed site is located on private land surrounded by both undeveloped private land and BLM managed lands. Field surveys were conducted from February 26 to March 2, 2007 to identify critical and important terrestrial habitats that may occur within the Roswell site. There is no critical habitat at the site. The only important terrestrial habitat at the site is that associated with the sand dune/shinnery oak habitat on the western portions of the site. The ecological site types located in this area provide habitat for the lesser prairie-chicken and for the sand dune lizard, which are both federal candidate species. This habitat is located on the eastern edge of an expansive area of similar sand dune/shinnery oak habitat that is primarily managed by the BLM. Important habitat areas surrounding this site have been addressed in sufficient detail to allow for the proposed environmental reviews. Review of the critical and important terrestrial habitat surrounding the Roswell site led to the conclusions that:

- There is no critical habitat at the site.
- The most important terrestrial habitat at the site is that associated with the sand dune/shinnery oak habitat on the western portion of the site.
- The ecological sites in the area provide habitat for the lesser prairie-chicken (*Tympanuchus pallidicinctus*) and for the sand dune lizard (*Sceloporus arenicolus*), which are both federal candidate species.
- Because of the abundance of these habitats in the region, it is expected that construction and operation of the GNEP facilities would not have any detrimental effects on populations of plants or animals in the region.

4.2 Background

This section briefly describes regulatory requirements for critical habitat, provides a large-scale ecological description of the Roswell site, summarizes regional climatology, describes site specific soils and primary ecological sites present within the Roswell site boundary, and describes the field methodology that was employed to identify critical and important habitat at the Roswell site.

4.2.1 Regulatory Requirements

The ESA requires the federal government to designate “critical habitat” for any species it lists under the ESA. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

Under Section 7 of the ESA, all federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat. These complementary requirements apply only to federal agency actions, and the latter only to habitat that has been designated as critical. A critical habitat designation does not set up a preserve or refuge, and applies only when federal funding, permits, or projects are involved. Critical habitat requirements do not apply to citizens engaged in activities on private land that do not involve a federal agency.

Section 5, Threatened or Endangered and Special Concern Species, discusses ESA-listed species. There are two ESA-listed candidate species that could occur within the Roswell site – the lesser prairie-chicken and sand dune lizard – but no critical habitat has been formally designated within or near the Roswell site for these species; thus critical habitat is not an issue for this site.

Important terrestrial habitats can be defined in a number of different ways; for the purpose of this report, a broad definition of important terrestrial habitat has been adopted and is described as that which, 1) is present within the site boundary, and 2) provides significant habitat to plant and/or animal species that might not be abundant elsewhere in the vicinity of the Roswell site. Important species are described as those that 1) have high public interest, economic value, or both, or 2) may be critical to the structure and function of the ecosystem or provide a broader ecological perspective of the area.

4.2.2 Major Land Resource Areas

Land Resource Regions provide a large-scale description of the resource conditions present within a region. Land Resource Regions are the basic units from which Major Land Resource Areas (MLRAs) (4-004) are determined. The Roswell site is located near the boundaries of two Land Resource Regions – the Western Range and Irrigated Region and the Western Great Plains Range and Irrigated Range. Within these two Land Resource Regions, the two MLRAs near the Roswell site are the Southern Desertic Basins, Plains, and Mountains MLRA and the Upper Pecos River Valley MLRA. Because the Roswell site is near the boundary of these two regions conditions characteristic of both may be present. Therefore both are briefly described below.

4.2.2.1 The Southern Desertic Basins, Plains, and Mountains

This MLRA is distinguished by intermontane desert basins and broad valleys bordered by gently sloping to strongly sloping bajadas, alluvial fans, and terraces. This MLRA supports desert grass-shrub vegetation typical of the entire Roswell site, but more strongly represented on the eastern portions of the Roswell site. The major soil resource concerns are wind erosion, water erosion, and vegetation diversity on rangeland. The vegetative cover is typically sparse, providing little protection against wind and water erosion. The soils have a low content of organic matter, resulting in little resistance to erosive forces (4-004).

4.2.2.2 The Upper Pecos River Valley

This MLRA is characterized by piedmont plains and tablelands formed by sedimentary rocks. Gently undulating to rolling plains and sandhills are interspersed with relatively smooth valleys and basins. A few small mesas and buttes also occur throughout this MLRA. The native vegetation of this area consists of species typical of short or mid grass prairie in the lowlands and piñon and juniper at the higher elevations and on steeper north-facing slopes (4-004). Characteristics of this MLRA are primarily represented on the western portions of the Roswell site.

4.2.3 Climate

Climatology of the area is discussed in greater detail in Section 10, Weather/Climatology. Climate information is presented here to show its influence on the vegetation that occurs in the general geographic area. New Mexico has a mild, arid to semi-arid, continental climate (4-027). Temperatures in the region are characterized by a distinct seasonal change and large annual and diurnal temperature ranges. Summers are moderately warm with maximum temperatures averaging above 90°F from June to August. Winters are sunny and dry, with temperatures averaging in the high 30s and low 40s. Annual average precipitation is approximately 15 inches. Approximately 80 percent of the moisture usually falls during the six month period of May through October, which is the dominant growing season of native plants (4-007). Most of this summer precipitation falls in the form of brief and heavy afternoon and evening thunderstorms. Winter precipitation is usually in the form of rain; occasional snowstorms of short duration also occur in the area. Snow seldom lies on the ground for more than a few days. Strong winds are common in the area and accelerate soil drying at a time for cool season plant growth. These winds increase transpiration rates of native plants and rapidly dry the surface soil.

4.2.4 Ecological Site Descriptions

An ecological site is the product of all the environmental factors responsible for its development. Ecological sites have characteristic soils, which are developed over time and support a characteristic plant community. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species. The plant and soil community of the ecological site is influenced by hydrology and thus are all interrelated. Ecological sites associated with the soil types found at the Roswell site are described below and are followed by descriptions of the soil types and characteristic vegetation.

4.2.4.1 Loamy Ecological Site

The Loamy Ecological Site has an arid climate with distinct seasonal temperature variations and large annual and diurnal temperature changes characteristic of a continental climate. Vegetation on this site is predominantly grassland characterized by short grasses. A minor component of the plant community is comprised of perennial shrubs, half-shrubs, and forbs. Annual forbs are present in relatively large amounts during spring and summer in years with above average plant growing conditions. When the plant community deteriorates, there is a marked increase in amounts of half-shrubs, forbs, and cacti (4-001).

This ecological site provides habitats that support a resident animal community that is typically characterized by coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), plains pocket gopher (*Geomys bursarius aernarius*), banner-tailed kangaroo rat (*Dipodomys spectabilis*), southern plains woodrat (*Neotoma* spp.), burrowing owl (*Athene cunicularia*), scaled quail (*Callipepla squamata*), meadowlark (*Sturnella* spp.), and brown towhee (*Pipilo fuscus*). These sites may also be utilized in the winter by flocks of rufous-crowned sparrow (*Zonotrichia leucophrys*), and black-throated sparrows (*Amphispiza bilineata*) (4-001).

4.2.4.2 Deep Sand Ecological Site

The Deep Sand Ecological Site has an arid climate similar to the Loamy site described above. The historic plant community type of this site is dominated by dropseeds (*Sporobolus* spp.); however, black grama (*Bouteloua eriopoda*) and bush muhly (*Muhlenbergia porteri*) are also important grasses. Under heavy grazing pressure, the more palatable black grama and bush muhly decline, and eventually dropseeds decline. Common shrubs on this site, such as sand sagebrush (*Artemisia filifolia*) and broom dalea (*Gutierrezia sarothrae*), tend to increase in representation and cover with grazing. Honey mesquite (*Prosopis glandulosa*) may also invade or increase under some circumstances. In some areas, only a few shrub species may dominate, shrub and grass cover is sparse, and mesquite may form coppice dunes. Where gravel content is high (e.g., >5 percent), creosote bush (*Larrea tridentate*) may also be present (4-001).

This ecological site provides habitat that supports a resident animal community that is typically characterized by pronghorn antelope *(Antilocapra americana)*, kit fox (*Vulpes macrotis*), spotted ground squirrel (*Spermophilus spilosoma*), desert pocket mouse (*Chaetodipus penicillatus*), Ord's kangaroo rat (*Dipodomys ordii*), southern plains wood rat, scaled quail, roadrunner (*Geococcyx californianus*), burrowing owl, desert horned lizard (*Phrynosoma platyrhinos*), and Couch's spadefoot toad (*Scaphiopus couchii*). White necked raven (*Corvus albicollis*) and mourning dove (*Zenaida macroura*) may nest on this site where large mesquite and yucca (*Yucca* spp.) are present. Deterioration produces a dune-interdune aspect with mesquite invasion, animal population densities shift in favor of burrowing mammals, their predators, and shrub dependent birds (4-001).

4.2.4.3 Sandy Plains Ecological Site

The Sandy Plains Ecological Site occurs on level to gently undulating sloping eolian and alluvial sediments on the uplands. The climate of this area can be classified as semi-arid continental. Warm season grasslands dominated by mid and tall grasses mixed with shrubs and a variety of forbs define this site. Temperature and rainfall distribution favors warm-season, perennial plant communities. However, sufficient late winter and early spring moisture allows cool season species to occupy a minor component within the plant community. The forb composition fluctuates from year to year depending upon moisture conditions. Because of the coarse surface textures, the soils, if unprotected by plant cover and organic residue, become wind blown and low hummocks or dunes are formed around shrubs (4-002, 4-003).

This ecological site provides habitats that support a resident animal community that is typically characterized by pronghorn antelope, desert cottontail, hispid pocket mouse (*Chaetodipus hispidus*), Ord's kangaroo rat, lesser prairie-chicken, burrowing owl, plains spadefoot toad (*Spea bombifrons*), and ornate box turtle (*Terrapene ornata*). The upland plover (*Bartramia longicauda*) and the savannah sparrow (*Passerculus sandwichensis*) are breeding birds of this site (4-003).

4.2.4.4 Sandhills Ecological Site

The Sandhills Ecological Site occurs on plains with slopes ranging from gently sloping to hilly and sometimes steep. The climate is semi-arid continental. Temperature and rainfall both favor warm season perennial plant growth. In years of abundant spring moisture, annual forbs and cool season grasses can make up an important component of this site. Because of the texture of this soil, most rainfall is effective and results in good plant growth (4-001).

The Sandhills Ecological Site occurs adjacent to or intergrades with the Deep Sand site. The Sandhills site is differentiated from Deep Sand sites by a steeper average slope and an increased depth to a soil texture change. Sandhills slopes are usually greater than 8 percent, and the soil profile is a fine sand or loamy fine sand to a depth greater than 60 inches. The historic plant community of the Sandhills site is a mixture of grasses, shrubs and forbs, with tall grasses dominating in aspect. During years of abundant spring moisture, tall growing forbs occasionally reach aspect dominance. Sand bluestem (*Andropogon halli*) and giant dropseed (*Sporobolus giganteus*) are the dominant grasses, with Havard's panicum (*Panicum havardii*) and dropseeds as sub-dominants. Sand shinnery oak (*Quercus havardii*) and soapweed yucca (*Yucca glauca*) are the dominant shrubs. Drought favors shinnery oak by impacting grasses more severely. Grass cover is variable; shifting sands and large irregular dunes produce considerable variation in the spatial distribution and composition of the plant community. Grass cover is not continuous, but is fairly uniform across the more stable areas. Large natural bare areas or blowouts are a common feature on the less stable portions of the Sandhills site (4-001).

This site provides habitat which support a resident animal community that is typically characterized by pronghorn antelope, black-tailed jackrabbit, Ord's kangaroo rat, northern grasshopper mouse (*Onychomys leucogaster*), southern plains woodrat, swift fox, roadrunner, meadowlark, lark bunting (*Calamospiza melanocorys*), ferruginous hawk (*Buteo regalis*), lesser prairie-chicken, mourning dove, scaled quail, sand dune lizard, marbled whiptail (*Cnemidophorus tigris*), ornate box turtle, bullsnake (*Pituophis melanoleucus*), and western diamondback rattlesnake (*Crotalus atrox*). Grasshopper sparrow (*Ammodramus savannarum*) and vesper sparrows (*Pooecetes gramineus*) utilize the site during migration. The ferruginous hawk sometimes nests on dunes associated with the site. White-tailed deer (*Odocoileus virginianus*) are also sometimes associated with this site (in the Mescalero Sands area). Where mesquite invades, nesting species of birds include white-necked raven, roadrunner, mourning dove, and Harris hawk (*Parabuteo unicinctus*). Where sand hummocks form around shrubs, rodent populations and their predators increase. Fourwing saltbush (*Atriplex canascens*), shinnery oak, sand sagebrush, and mesquite provide protective cover and seed, green herbage, and fruit from a variety of grasses, forbs, and shrubs provide food for a number of birds and mammals (4-001).

4.2.5 Characteristic Vegetation

Table 4-1 contains information about the characteristic vegetation associated with the ecological sites and soil types described above (4-005). Characteristic vegetation describes the grasses, forbs, and shrubs that make up most of the potential natural plant community for a site. A characteristic natural plant community differs from natural plant communities on other ecological sites in kind, amount, and proportion of plants present. The concept of potential natural plant community is evaluated to determine the present condition of the vegetation in relation to its potential. The more closely the existing community resembles the potential community, the better the range condition.

Table 4-1. Soil types, ecological sites, and characteristic vegetation.

Soil Name	Ecological Site	Characteristic Vegetation	Rangeland Percent Composition[a]
Faskin	Sandy Plains	Black grama	20
		Blue grama	15
		Other perennial grasses	10
		Plains bristlegrass	10
		Sideoats grama	10
		Arizona cottontop	5
		Buffalograss	5
		Hairy grama	5
		Hooded windmill grass	5
		Other perennial forbs	5
		Other shrubs	5
		Sand dropseed	5
Roswell	Sandhills	Sand bluestem	20
		Dropseed grasses	15
		Other perennial grasses	15
		Giant sandreed	10
		Little bluestem	10
		Other perennial forbs	10
		Other shrubs	10
		Sand sagebrush	5
		Yellow indiangrass	5
Jalmar	Deep Sand	Giant dropseed	10
		Havard’s (shinnery) oak	10
		Little bluestem	10
		Sand bluestem	10
		Annual grasses	5
		Cane bluestem	5
		Hooded windmill grass	5
		Mesa dropseed	5
		Other perennial grasses	5
		Plains bristlegrass	5
		Sand dropseed	5
		Sand paspalum	5
		Sideoats grama	5
		Spike dropseed	5
		Threeawn grasses	5

Table 4-1. (continued).

Soil Name	Ecological Site	Characteristic Vegetation	Rangeland Percent Composition[a]
Alama	Loamy	Tobosagrass	30
		Black grama	15
		Other perennial grasses	15
		Blue grama	10
		Bush muhly	5
		Little bluestem	5
		Other perennial forbs	5
		Other shrubs	5
		Plains bristlegrass	5
		Threeawn grasses	5
		Yucca species	5
Ima	Sandy Plains	Dropseed grasses	15
		Little bluestem	15
		Other perennial grasses	15
		Sand bluestem	15
		New Mexico feathergrass	10
		Other perennial forbs	10
		Other shrubs	10
		Plains bristlegrass	5

a. Individual species percent composition rounded to nearest 5 percent.

4.2.6 Soils

Within a particular area, differences in the type and amount of rangeland vegetation are closely related to the type of soil. Therefore, soil type information is important because it determines vegetation present and habitat suitability for wildlife species. There are four main soil map units within the Roswell site (see Figure 4-1; 4-005).

A soil map unit delineation, such as those shown for the Roswell site (see Figure 4-1), represents an area dominated by one or more major kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, the soils are natural phenomena and as such they exhibit variability. Thus, the range of some observed properties may extend beyond the limits defined for a particular taxonomic class. The objective of soil mapping is to separate the landscape into landforms or landform segments that have similar use and management requirements.

The primary soils on the Roswell site are the Faskin-Roswell complex, Roswell-Jalmar complex, Alama loam, and Ima fine sandy loam (Table 4-2; 4-005). Brief descriptions of these are provided below. An important component of the soil description is the associated ecological site description. The ecological sites are described in Section 4.2.4.

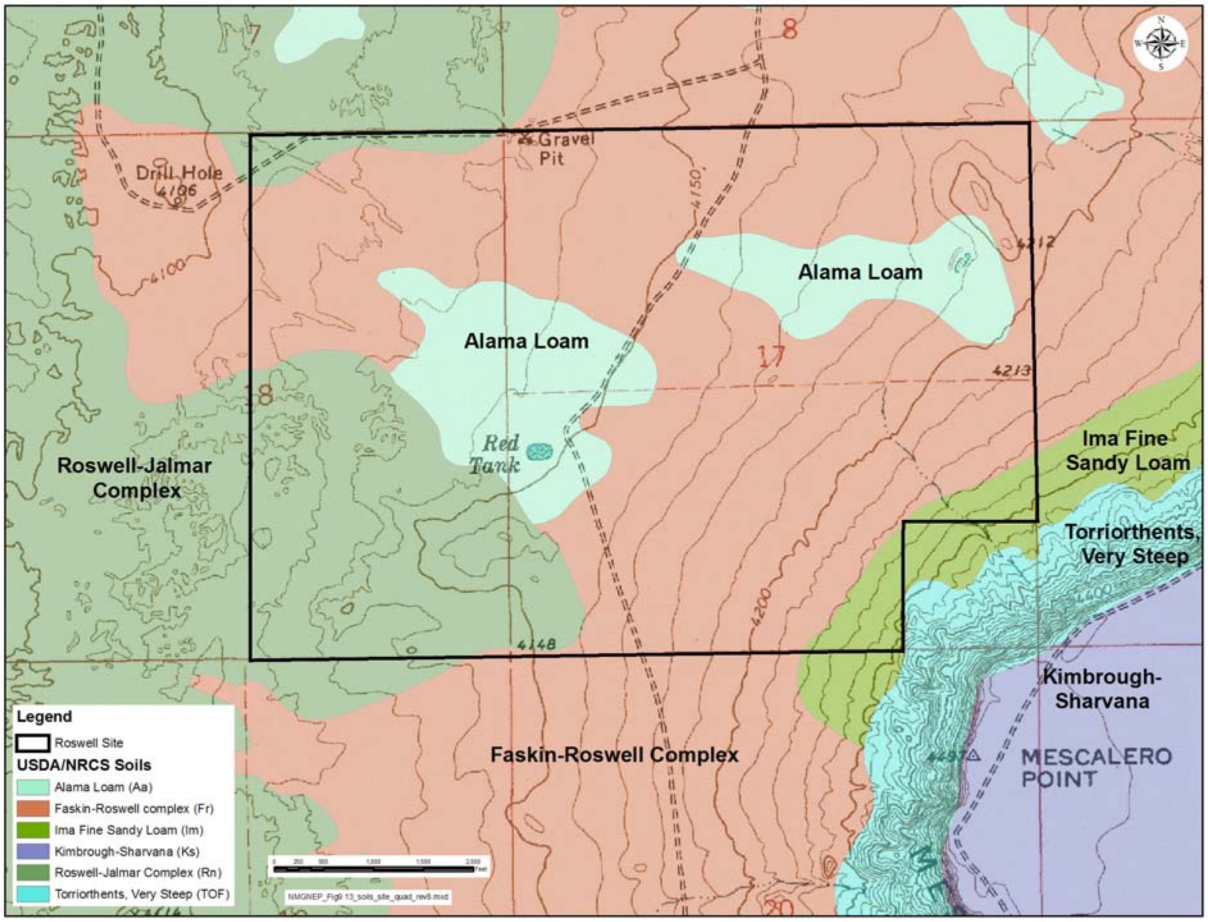

Figure 4-1. Soil map units present in the Roswell site (4-004). Table 4-2 identifies the map units and their aerial extent.

Table 4-2. Map units present at the Roswell site.

Map Unit Symbol	Map Unit Name	Acres in Roswell Site	Percent of Roswell Site
Fr	Faskin-Roswell complex	560	61
Rn	Roswell-Jalmar complex	180	20
Aa	Alama loam	147	16
Im	Ima fine sandy loam	31	3

4.2.6.1 Faskin-Roswell Complex

As shown in Table 4-2, the Faskin-Roswell complex is the prevalent soil in the Roswell site accounting for approximately 61 percent of the Roswell site. The Faskin component, representing 55 percent of the Faskin-Roswell complex, is located in the Sandy Plains Ecological Site (4-006), and is found on plains and 0 to 3 percent slopes. The parent material consists of mixed alluvium and/or eolian deposits derived from sedimentary rock. The Roswell component, representing 30 percent of the Faskin-Roswell complex, is located in the Sandhills Ecological Site (4-006) and is found on plains and 3 to 15 percent slopes. The parent material consists of mixed alluvium and/or eolian deposits derived from sedimentary rock. The remaining 15 percent of the complex is made up of minor components with properties similar to those of the dominant soils of the complex.

4.2.6.2 Roswell-Jalmar Complex

The Roswell-Jalmar complex is the second most prevalent soil type within the Roswell site accounting for approximately 20 percent of the area. The Roswell component, representing 60 percent of the Roswell-Jalmar complex, is located in the Sandhills Ecological Site (4-006), and is found on 10 to 15 percent slopes. The parent material consists of mixed alluvium and/or eolian deposits derived from sedimentary rock. The Jalmar component, representing 25 percent of the Roswell-Jalmar complex, is located in the Deep Sand Ecological Site (4-006). This soil type is found on alluvial fans, plains and 0 to 3 percent slopes. The parent material consists of mixed alluvium and/or eolian deposits derived from sedimentary rock. The remaining 15 percent of the complex is made up of minor components with properties similar to those of the dominant soils of the complex.

4.2.6.3 Alama Loam

Alama loam soils account for approximately 16 percent of the site and are found in two discrete patches surrounded by Faskin-Roswell or Roswell-Jalmar complex soils. The Alama component representing 85 percent of the Alama Loam map unit, is located in the Loamy Ecological Site, and is found on valleys, flood plains and 0 to 3 percent slopes. The parent material of Alama loam soils consists of calcareous alluvium derived from sedimentary rock (4-006). The remaining 15 percent of the complex is made up of minor components with properties similar to those of the dominant soils of the complex.

4.2.6.4 Ima Fine Sandy Loam

The Ima fine sandy loams are found on the southeastern corner of the property adjacent to the very steep Torriorthents that make up the base of the Mescalero Ridge. The Ima component representing 85 percent of the Ima Fine Sandy Loam map unit, is located in the Sandy Plains Ecological Site, and is found on plains and slopes of 1 to 5 percent. The parent material consists of mixed alluvium and/or eolian deposits derived from sedimentary rock (4-006). The remaining 15 percent of the complex is made up of minor components with properties similar to those of the dominant soils of the complex.

4.3 Results

Surveys were conducted from February 26 though March 2, 2007, by walking parallel transects across the entire Roswell site at 15-meter intervals. A crew of six personnel was used and included both botanists and wildlife biologists. The results of the surveys (described below) are not intended to provide a comprehensive listing of all plant and animal species likely to occur at the Roswell site, but rather are intended to field verify the background information described above and to carefully examine the Roswell site for any important plant or animal species or habitat that could be potentially disturbed by construction and operation of the GNEP facilities. The field survey results section describes the plant and animal communities and associated habitats that were observed during the 2007 field survey. Plant community types and distributions across the Roswell site were noted and dominant species identified. Some plants were unidentifiable to the species level due to the season of the survey. All animal species that were seen during the surveys were also noted.

4.3.1 Plant Communities

Within the Roswell site, the vegetation is somewhat varied by soil type, but is dominated by two plant communities. Because the survey was conducted in late winter, identification of plants, especially grasses and forbs, was largely dependent upon senescent plant material and standing litter on the site. The western portions of the Roswell site (particularly in Section 18) are composed of deep, hilly, sandy soils that are dominated by honey mesquite, shinnery oak, broom snakeweed (*Gutierrezia sarothrae*), sand bluestem, little bluestem (*Schizachyrium scoparium*), and other perennial grasses and forbs (see Figure 4-2). These plant communities tend to anchor and stabilize the sand producing small dunes. The eastern portions of the Roswell site (particularly Section 17) are less sandy and hilly than the western third and are dominated by creosote bush, honey mesquite, broom snakeweed, grama grasses, and other perennial grasses and forbs (see Figure 4-3). Yucca and cactus species (prickly pear and cholla [*Opuntia* spp.]) are also scattered across the Roswell site.

The Roswell site is currently grazed by livestock (see Section 4.3.2.2). Consequently, there is an increase in the abundance of shrub, half shrub, and forb species and a decrease in the abundance of grass species from what would be expected under characteristic conditions (see Table 4-1 and associated discussion above). A few weedy forb species are also prevalent around livestock watering points, most notably Red Tank (see Section 2, Aquatic and Riparian Ecological Communities).

Figure 4-2. Mesquite, shinnery oak, grasses and forbs typical of the sandy western part of the Roswell site. A portion of the Mescalero Ridge is seen in the background (view to southeast).

Figure 4-3. Creosote bush, mesquite, grasses and forbs typical of the eastern part of the Roswell site. Sand dunes on BLM-managed land to the west can be seen in the background.

4.3.1.1 Important Terrestrial Habitat

The most important vegetation communities on the Roswell site are those that provide habitat for the lesser prairie-chicken and sand dune lizard. These are both federal candidate species and are further discussed in Section 5, Threatened or Endangered and Special Concern Species. The sand dune/shinnery oak habitat that is typical of the western third of the Roswell site (roughly that encompassed by Section 18) provides habitat for these two species.

Suitable habitat for the lesser prairie-chicken is present within the Roswell site. The BLM has included Section 18 of the site within a designated area of known occupied lesser prairie-chicken habitat. The closest active lek is located approximately 2 miles west of the Roswell site in Section 15; Township 11 South; Range 30 East. There are approximately 10 active or historic leks located within a 5-mile radius of the Roswell site (all of which are located west of Section 18) (4-028). The sand dune/shinnery oak habitat located within the site is located on the eastern fringe of a large geographic area of suitable lesser prairie-chicken habitat.

The sand dune lizard is endemic to a small area in southeastern New Mexico (Chaves, Eddy, Lea, and Roosevelt Counties) and adjacent west Texas (Andrews, Crane, Ward, and Winkler Counties), and its distribution is restricted to sand dune blowouts associated with active sand dunes with shinnery oak and scattered sand sage (*Artemisia filifolia*). Suitable habitat for the sand dune lizard is present within the Roswell site. The sand dune habitat located within the western two-thirds of Section 18 was found to have suitable habitat and has been documented by the BLM as containing a viable population of the sand dune lizard (4-019). The sand dune/shinnery oak habitat within the site is located on the eastern fringe of a large geographic area of sand dune habitat.

The majority of the plant communities on the site is typical of much of southeastern New Mexico and western Texas and provides hunting, foraging, nesting, and shelter habitat for a variety of common animal species. Because of the abundance of these habitats in the region, it is expected that construction and operation of the GNEP facilities will not have any detrimental effects on populations of plants or animals in the region; however, some individuals are likely to be impacted. Other wildlife present or potentially present in these habitat types is discussed below.

4.3.1.2 Noxious Weeds

The State of New Mexico (4-022) and the Southwest Exotic Plant Information Clearinghouse (4-023) maintain a noxious weed list of invasive plants which are controlled to varying degrees. There are currently 32 listed noxious weeds within the State of New Mexico. These are further classified into Class A (highest priority; not present or limited distribution within the state), Class B (limited to certain areas of the state), and Class C (wide spread distribution within the state) noxious weeds. Within the eastern portions of Chaves County where the project site is located, there are six noxious weed species that have the potential to occur. These are perennial pepperweed (*Lepidium latifolium*), African rue (*Peganum harmala*), bull thistle (*Cirsium vulgare*), Malta starthistle (*Centaurea melitensis*), musk thistle (*Carduus nutans*), and Russian knapweed (*Acroptilon repens*). No noxious plant species were observed on the site during the field surveys.

4.3.2 Animal Communities

There are four main ecological site types that are known to occur within the boundary of the Roswell site (see Section 4.2.4). These ecological site types support habitat for a wide variety of wildlife species. There are no riparian, wetlands, or aquatic habitats present within or directly adjacent to the Roswell site; therefore species associated with these habitat types are not anticipated to be found within the Roswell site (see additional discussion in Section 2, Aquatic and Riparian Ecological Communities). Some moist areas associated with scattered stock tanks provide limited habitat for a few amphibian species.

4.3.2.1 General Wildlife

The habitat within the Roswell site has the potential to support a variety of common mammals, birds, reptiles, and some amphibians. The privately owned 980-acre Roswell site is located within the Caprock Wildlife Habitat Management Area (WMA) (4-010), which encompasses approximately 561,300 acres of public, state, and private lands in eastern Chaves County, southwestern Roosevelt County, and northern Eddy County, New Mexico (4-026). The WMA was established to protect the Mescalero Sands habitat area that is located primarily to the west of the Roswell site; protection of this habitat is primarily focused on the lesser prairie-chicken.

The types of wildlife that may be found in the Roswell site are summarized below. The majority of this information comes from the BLM who manage much of the land to the west of the site and from the field surveys that were carried out specifically for this project.

Mammals

Mule deer (*Odocoileus hemionus*), pronghorn antelope, black-tailed jackrabbit, desert cottontail, coyote, striped skunk (*Mephitis mephitis*), and a few small rodents represent the common mammalian species observed within or adjacent to the Roswell site during the 2007 field survey. Mule deer tend to reside more commonly within the shinnery oak dune habitats and were observed near the stock pond (Red Tank) near the center of the site. Pronghorn antelope tend to utilize the more open grasslands but also frequent the shinnery oak habitat (4-019). Other mammals that are anticipated to occur in the area but were not observed during the field survey include badger (*Taxidea taxus*), gray fox (*Urocyon cinereoargenteus*), plains pocket gopher, spotted ground squirrel, desert pocket mouse, hispid pocket mouse, deer mouse (*Peromyscus maniculatus*), and gray shrew (*Notiosorex crawfordi*). Some hunting occurs on the Roswell site by the landowner, but populations of game species are fairly low. There are no mammal species within the Roswell site of high public interest or economic value, or that may be critical to the structure and function of the ecosystem, that would be negatively impacted by the construction or operation of the GNEP facilities.

Birds

The desert scrub shrub habitat present within the Roswell site provides habitat for a wide variety of songbirds, raptors, and game bird species. Common birds that were observed during the field surveys include loggerhead shrike (*Lanius ludovicianus*; only sign noted), black-throated sparrow, mourning dove (a game bird), scaled quail (a game bird), Chihuahuan raven (*Corvus cryptoleucus*), Swainson’s hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), and prairie falcon (*Falco mexicanus*). Other common bird species that likely occur in the area include the meadowlark, lark bunting, brown towhee, ferruginous hawk, turkey vulture (*Cathartes aura*), and the lesser prairie-chicken (a federal candidate species). The habitats and ecological site types within the Roswell site boundary provide habitat for migratory bird species that are protected under the Migratory Bird Treaty of 1918. There are multiple small songbirds (e.g., grasshopper sparrow and vesper sparrow) that use these habitat types as wintering habitat during their seasonal migration and may be present on the Roswell site during certain times of the year. Some hunting of game birds occurs on the Roswell site by the landowner. The most important habitat for bird species within the Roswell site is the sand dune/shinnery oak habitat (discussed in Section 4.3.1.1) that is suitable for lesser prairie-chicken. This habitat is located on the far western edge of the Roswell site and is located on the eastern fringe of a large geographic area of similar habitat that is primarily managed by the BLM.

Reptiles and Amphibians

The ecological site types within the Roswell site boundary support habitat for many reptile species and the isolated moist areas around stock tanks provide suitable habitat for a few amphibian species. Lizards were abundant during the 2007 field survey with the highest concentrations of individuals associated with the dune habitat in Section 18 on the western side of the site. Lizard species known to occur in the area include the lesser earless lizard (*Holbrookia maculata*), round-tailed horned lizard (*Phrynosoma modestum*), sand dune lizard (a federal candidate species), side-blotched lizard (*Uta stansburana*), and various whiptail species (*Cnemidophorus* spp.). No snakes were observed during the survey, but a number of species are abundant in the area including the western rattlesnake (*Crotalus viridis*), western diamondback rattlesnake, gopher snake (*Pituophis melanoleucus*), common king snake *(Lampropeltis getula*), and Texas blind snake (*Leptotyphlops dulcis*). Amphibian species that potentially occur within or adjacent to moist areas associated with stock watering tanks include the ornate box turtle (seen during the field survey), Great Plains toad (*Bufo cognatus*), and spadefoot species (*Spea* spp.). The most important habitat for reptiles within the Roswell site is the sand dune/shinnery oak habitat (discussed in Section 4.3.1.1 above) that is suitable for the sand dune lizard. This habitat is located on the far western edge of the site, which itself is located on the eastern fringe of a large geographic area of similar habitat that is primarily managed by the BLM.

4.3.2.2 Domestic Animals

The Roswell site and the public lands located adjacent to it are used for livestock grazing, primarily by cattle and horses. Section 18 of the Roswell site is included in the West Mescalero Point Grazing Allotment administered by the BLM. This allotment is comprised of 10,695 acres of BLM lands, 1,273 acres of State lands and 2,787 acres of private lands. The BLM lands contain 1,840 animal unit months (AUMs), the State lands contains 204 AUMs, and the private land contains 584 AUMs (4-025). An AUM is a unit of measure used to determine the amount of forage material that is available to support a single animal for one calendar month. The Roswell site is currently fenced into three pastures; the two eastern pastures were being used to graze approximately 40 cattle (cow-calf pairs) and 2 horses during the 2007 field survey.

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CONTENTS

TABLES

5. THREATENED OR ENDANGERED AND SPECIAL CONCERN SPECIES

This section describes threatened or endangered and special concern species that occur within or are near the proposed Roswell GNEP site that have the potential to be disturbed by construction and operation of the GNEP facilities. Section 2, Aquatic and Riparian Ecological Communities, describes any aquatic communities, including fish and shellfish, commercial and sport fisheries, and riparian communities at or near the Roswell site. Special status species (i.e., species covered under the ESA or of special concern to other federal, state, or local agencies), including any aquatic or riparian habitat related species, are discussed in this section. More detailed information on general plant and animal communities that occur at the site are provided in Section 4, Critical and Important Terrestrial Habitats.

5.1 Overview and Summary

Literature and field surveys were conducted to identify threatened, endangered, and species of special concern that occur within or near the Roswell site. Thirty-six species were identified as occurring within Chaves County. Suitable or marginally suitable habitat is present within or adjacent to the Roswell site for only eight of the identified 36 special status species. The remaining species are associated with riparian, wetland, or riverine habitat which is absent in or adjacent to the Roswell site.

The only two species that have been documented within or adjacent to the Roswell site are the sand dune lizard and lesser prairie-chicken. The species that are thought to potentially occur at the site, or within 10 kilometers (6 miles) of the Roswell site, are listed below.

- **Sand Dune Lizard.** The sand dune lizard is currently listed as a threatened species by the State of New Mexico. Suitable habitat for the sand dune lizard is present within the Roswell site.

- **Lesser Prairie-Chicken.** The lesser prairie-chicken is being considered for inclusion as a threatened species and therefore considered a candidate species. Suitable habitat for the prairie-chicken was identified within and adjacent to the Roswell site.

There is marginal habitat for five species of concern within the Roswell site. There was no sign of these species observed during the 2007 field survey.

- **Northern Aplomado Falcon.** The northern aplomado falcon is listed as an endangered species. There is marginal habitat for the northern aplomado falcon, a federally listed endangered species. No sign of the northern aplomado falcon was noted during the 2007 field survey. Additional surveys may be needed.

- **Baird's Sparrow.** The Baird's sparrow is considered a species of concern. The Roswell site supports habitat that is used annually for wintering by the sparrow.

- **Western Burrowing Owl.** The western burrowing owl is considered a species of concern. The habitat present within the Roswell site is considered marginal for the burrowing owl. There were no signs of the owl observed during the 2007 field survey.

- **Black-tailed Prairie Dog.** The black-tailed prairie dog is a species of concern. A small amount of suitable habitat is associated with the Roswell site. There were no signs of individual prairie dogs or colonies observed during the 2007 field survey.

- **Swift Fox.** The swift fox is a species of concern. Habitat in and adjacent to the Roswell site is marginal for the swift fox. There were no signs of swift fox observed during the 2007 field survey.

- **Townsend Big-eared Bat.** The Townsend big-eared bat is a species of concern. There are no suitable nesting caves or caverns in or adjacent to the Roswell site. However, individuals may transit through the Roswell site.

5.2 Background

This section provides a summary of pertinent regulatory information, a list of the special status species known to occur in Chaves County, and a description of the field methodology.

5.2.1 Regulatory Information

The ESA of 1973, as amended, is Federal legislation that is intended to provide a means to conserve the ecosystems upon which endangered and threatened species depend and provide programs for the conservation of those species, thus preventing extinction of plants and animals (5-036). Depending on the type of species being protected, the law is administered by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS).

There are three designations given to species under ESA that offer protection to plants and animals that have been found to warrant protective measures to ensure their survival and existence. These designations are endangered, threatened, or candidate species. An endangered species is an animal or plant species in danger of extinction throughout all or a significant portion of its range; a threatened species is an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range; and a candidate species is a plant or animal species for which the USFWS or U.S. Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA) NMFS has on file sufficient information on biological vulnerability and threats to support a proposal to list the species as endangered or threatened (5-036).

Section 7 of the ESA requires all Federal agencies, in consultation with USFWS or NMFS, to use their authorities to further the purpose of the ESA and to ensure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat. The interagency cooperation requirements of Section 7(a)(2) of the ESA are to be carried out in consultation with the Secretary of the Interior, via the USFWS. The need to initiate consultation is usually determined by the governing Federal agency, which in the case of the proposed project is the DOE, and is based on an analysis to determine if an individual of a federally listed species, or its designated critical habitat, may be affected by a proposed action. The DOE must initiate consultation if a listed species is known, or suspected, to occur on land that will be affected by an action, and the DOE determines that individuals, populations, or designated critical habitat of threatened or endangered species may be affected by the action, either positively or negatively.

The ESA requires the Federal government to designate “critical habitat” for any species it lists under the ESA. “Critical habitat” is defined as: 1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (5-036). An evaluation of critical habitat for the Roswell site is provided in Section 4, Critical and Important Terrestrial Habitats.

A species of concern is an informal term used by the USFWS and NMFS as well as other government agencies (e.g., BLM and New Mexico Department of Game and Fish [NMDGF]), which refers to a species that might be in need of conservation action or that is considered sensitive, rare, or declining on lists maintained by Natural Heritage Programs, State wildlife agencies, other Federal agencies, or professional/academic scientific societies. This may range from a need for periodic monitoring of populations and threats to the species and its habitat, to the necessity for listing as threatened or endangered. Such species receive no legal protection and use of the term does not necessarily imply that a species will eventually be proposed for listing. Due to the close proximity of lands managed by the BLM Roswell Field Office species of concern identified by the BLM are discussed within this document.

Additional major legislation requiring actions by Federal agencies to protect threatened and endangered species, as well as other protected, non-Federally listed species and habitats, include but are not limited to the following:

- Fish and Wildlife Conservation Act of 1980,
- Fish and Wildlife Coordination Act of 1958,
- Migratory Bird Treaty Act of 1918 as amended, and
- Plant Protection Act of 2000.

In addition to Federal protection, species may be listed for protection by state government under New Mexico State Law 1978 Wildlife Conservation Act (5-006). A biannual review for each of the species protected under the Wildlife Conservation Act is performed to assess their status within the State of New Mexico. Further regulatory information pertinent to threatened or endangered species is discussed in Section 12, Regulatory and Permitting.

5.2.2 List of Special Status Species

A current list of the endangered, threatened, and candidate species, species of concern, and any designated critical habitat for Chaves County, New Mexico was obtained from the USFWS New Mexico Ecological Services Field Office.

The list for Chaves County contains a total of 36 species (nine endangered species, four threatened species, three candidate species, and twenty species of concern [SSC]) (5-004). These species occur in a wide variety of habitat types such as mountainous woodlands, aquatic and riparian areas, desert scrub shrub, and sand dune habitats. In a letter received in response to a species request, the USFWS stated that the county lists are not project specific; however, they will aid in determining which species may or may not occur within the identified area. Table 5-1 identifies the listed and sensitive species known or suspected to occur within Chaves County (5-004). The BLM lists two species known to occur within or near the Roswell site that they have identified as emphasis species in the 2006 Special Status Species, Draft Resource Management Plan Amendment and Environmental Impact Statement (5-030). These species are the lesser prairie-chicken and sand dune lizard.

Table 5-1. Listed and sensitive species in Chaves County.

Common Name	Scientific Name	Group	Status*
Species Known to Occur on the Roswell Site			
Sand dune lizard	*Sceloporus arenicolus*	Reptile	Candidate
Lesser prairie-chicken	*Tympanuchus pallidicinctus*	Bird	Candidate
Species that Potentially Occur Within the Roswell Site			
Northern aplomado falcon	*Falco femoralis*	Bird	Endangered
Baird's sparrow	*Ammodramus bairdii*	Bird	SSC
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	SSC
Black-tailed prairie dog	*Cynomys ludovicianus*	Mammal	SSC
Swift fox	*Vulpes velox*	Mammal	SSC
Townsend's big-eared bat	*Corynorhinus townsendii*	Mammal	SSC
Species that Occur Within the General Geographic Area But Do Not Have Suitable Habitat within the Roswell Site			
Pecos gambusia	*Gambusia nobilis*	Fish	Endangered
Pecos bluntnose shiner Designated Critical Habitat	*Notropis simus pecosensis*	Fish	Threatened
Greenthroat darter	*Etheostoma lepidum*	Fish	SSC
Headwater catfish	*Ictalurus lupus*	Fish	SSC
Pecos pupfish	*Cyprinodon pecosensis*	Fish	SSC
Rio Grande shiner	*Notropis jemezanus*	Fish	SSC
Least tern (interior)	*Sterna antillarum*	Bird	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Bird	Threatened
Mexican spotted owl Designated Critical Habitat	*Strix occidentalis lucida*	Bird	Threatened
American peregrine falcon	*Falco peregrinus anatum*	Bird	SSC
Arctic peregrine falcon	*Falco peregrinus tundrius*	Bird	SSC
Bell's vireo	*Vireo bellii*	Bird	SSC
Black tern	*Chlidonias niger*	Bird	SSC
Mountain plover	*Charadrius montanus*	Bird	SSC
Northern goshawk	*Accipiter gentilis*	Bird	SSC
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	SSC
Black-footed ferret	*Mustela nigripes*	Mammal	Endangered
Desert pocket gopher	*Geomys arenarius*	Mammal	SSC
Pecos River muskrat	*Ondatra zibethicus ripensis*	Mammal	SSC
Western red bat	*Lasiurus blossevillii*	Mammal	SSC
Koster's springsnail	*Juturnia kosteri*	Mollusk	Endangered
Pecos assiminea snail	*Assiminea pecos*	Mollusk	Endangered
Roswell springsnail	*Pyrgulopsis roswellensis*	Mollusk	Endangered
Noel's amphipod	*Gammarus desperatus*	Arthropod	Endangered
Texas hornshell	*Popenaias popeii*	Mollusk	Candidate
Kuenzler's hedgehog cactus	*Echinocereus fendleri var.*	Plant	Endangered
Pecos sunflower	*Helianthus paradoxus*	Plant	Threatened
Wright's marsh thistle	*Cirsium wrightii*	Plant	SSC

***Status:**
Endangered. Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened. Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Candidate. Taxa for which the USFWS has sufficient information to propose that they be added to the list of endangered and threatened species, but the listing action has been precluded by other higher priority listing activities.
SSC (Species of Concern). Taxa for which further biological research and field study are needed to resolve their conservation status or are considered sensitive, rare, or declining on lists maintained by Natural Heritage Programs, State wildlife agencies, other Federal agencies, or professional/academic scientific societies. Species of concern are included for planning purposes only.

5.2.3 Field Methodology

A field survey was conducted from February 26 to March 2, 2007 to determine habitat types present within the Roswell site and to assess the suitability of the habitat present for the 16 ESA-listed and 20 state-listed species that have been identified as occurring in Chaves County (see Table 5-1). The survey was conducted by walking transects throughout the Roswell site at 49-foot intervals. Information was collected on the vegetation types present within the Roswell site and general wildlife that was observed during the survey.

5.3 Species Descriptions and Results

This section provides a brief description of the species listed in Table 5-1 and summarizes the results of the literature search and field survey. Thirty-six special status species were identified as occurring in Chaves County; of these there is suitable or marginally suitable habitat present within or adjacent to the Roswell site for only eight of these species, as described below. More detailed information is provided for these eight species than for those species that are not likely to occur within or adjacent to the Roswell site. The eight species that have suitable or marginally suitable habitats present are listed below:

- Sand dune lizard,
- Lesser prairie-chicken ,
- Northern aplomado falcon,
- Baird’s sparrow,
- Western burrowing owl,
- Black-tailed prairie dog,
- Swift fox, and
- Townsend’s big-eared bat.

5.3.1 Species Known to Occur on the Roswell Site

There are two special status species known to occur on the Roswell site. These species are the sand dune lizard and the lesser prairie-chicken. Suitable habitat is present along the western portion of the site which comprises shinnery oak/sand dune habitat types.

Sand dune lizard (*Sceloporus arenicolus*)
The sand dune lizard is the only special status reptile species that has been identified as occurring in Chaves County. This species is closely monitored by the USFWS and BLM. The sand dune lizard is currently listed as a candidate species. The sand dune lizard was listed as threatened by the State of New Mexico in 1975. The Center for Biological Diversity and Chihuahuan Desert Conservation Alliance petitioned the USFWS on May 28, 2002 to list the sand dune lizard as an endangered species under ESA (5-030). In 1990, prior to this petition the NMDGF began the first of three intensive studies of this lizard. These studies were cooperative efforts of the USFWS, the BLM, New Mexico Oil and Gas Association, and the University of New Mexico (5-016). After the 2002 petition the USFWS recognized the severity of the threats to the sand dune lizard, and made it a candidate for listing, giving it the highest priority for action a species can receive (5-030).

Credit: www.biologicaldiversity.org /swcbd/species/dunelizard/index.html

The sand dune lizard (formerly known as the dunes sagebrush lizard) is a small reptile, from nose to tail about as long as a human hand. This blunt-nosed lizard has a rounded head, bright yellow eyes, and a faint yellow under-lip beneath its wide mouth. In coloration, it is well camouflaged with small scales of pale gray and tan. Along its back, faint brownish speckles extend in parallel lines from the ear openings to the base of the tail. While its front feet are small, its back feet are large and well suited for running and digging in sand. It has long, splayed, claw-tipped toes, the fourth digit being the longest. The sand dune lizard is active between April and September. Females can reach sexual maturity during their first spring following hatching. Females produce one to two clutches per year, averaging about five eggs each. Hatchlings appear between July and September. Sand dune lizards feed on ants, small beetles, crickets, grasshoppers, and spiders. Most feeding takes place within or adjacent to patches of vegetation (e.g., shinnery oak). Individuals are extremely wary, and when disturbed, take shelter in burrows, under the sand, or beneath leaf litter (5-017).

The sand dune lizard is endemic to a small area in southeastern New Mexico (Chaves, Eddy, Lea, and Roosevelt Counties) and adjacent west Texas (Andrews, Crane, Ward, and Winkler Counties). It has the second-most restricted range of any native lizard in the United States. Within this area, the known occupied and potentially occupied habitat is only 655 square miles in New Mexico, and an unknown amount in west Texas. The sand dune lizard's distribution is localized and fragmented (i.e., known populations are separated by vast areas of unoccupied habitat), and the species is restricted to sand dune blowouts associated with active sand dunes with shinnery oak (*Quercus havardii*) and scattered sand sage (*Artemisia filifolia*). Sand dune lizards are not found at sites lacking shinnery oak sand dune habitat (5-017). The preferred habitat includes dune areas characterized by hummock upon hummock of cool, white sand, partially stabilized by shinnery oak, bluestem grass species, yucca, and other plant species (5-016).

Suitable habitat for the sand dune lizard is present within the Roswell site (see Section 4, Critical and Important Terrestrial Habitat). The sand dune habitat located within the western two-thirds of Section 18 (corresponding to the western quarter of the Roswell site) was found to have suitable habitat and has been documented by the BLM as containing a viable population of the sand dune lizard (5-030). The sand dune/shinnery oak habitats located within the Roswell site are located on the eastern fringe of a large geographic area of sand dune habitat.

Lesser prairie-chicken (*Tympanuchus pallidicinctus*)

On July 8, 1997 (5-037), the USFWS published a 90-day finding on a petition to list the lesser prairie-chicken that it warranted consideration for listing as threatened under the ESA; therefore, it is considered as a candidate species.

The lesser prairie-chicken is an upland grassland-nesting bird present in regions of New Mexico and surrounding states. Related to the sharp-tailed grouse and differing only slightly from the greater prairie-chicken in color, size, and primarily in range, the lesser prairie-chicken is best known for its unique courtship displays and "gobbling" grounds. In the twentieth century, human influences such as the conversion of native rangelands to cropland, decline in habitat quality due to herbicide use, petroleum and mineral extraction activities, and excessive grazing of rangelands by livestock have contributed to this decline. Severe drought has also significantly impacted prairie-chicken populations. Due to these factors, the lesser prairie-chicken is now being considered by the USFWS as a species in need of protection through the ESA (5-001).

Native rangeland in different stages of plant succession and consisting of a diversity of native, short- to mid-height grasses and forbs interspersed with low-growing shrubby cover comprises optimum lesser prairie-chicken habitat. Lesser prairie chickens are found in and near habitats dominated by sandy soils with shinnery oak- bluestem or sand sage/bluestem vegetative communities. Specific habitats include breeding grounds (lek sites, booming grounds), nesting, brood rearing, summer foraging, and autumn-winter foraging areas. Lek sites are small (< 1 acre), usually slightly elevated, bare or sparsely vegetated areas of tighter soils where males call and perform ritualistic displays. Lesser prairie-chickens generally remain within a 2-mile radius of the lek site throughout the year. Nesting habitat usually consists of taller grasses and shrubs among low-lying sandhills. Generally, nest sites are in shinnery oak or sand sage grasslands having high canopy cover and moderate vertical and horizontal cover with residual vegetation from the previous growing season consisting of tall bunch grasses. Frequently, nests are located on north or northeast dune slopes to provide protection from southwest winds and direct sunlight. Brood rearing habitat is usually in the immediate vicinity of nests, but is more open at the ground level and has more shrubs and forbs. Summer foraging areas tend to be the same as brood rearing areas, but may include other areas such as cultivated and fallow fields, and fields planted back to grasses where protective cover from predators is less critical for adults than for broods. Autumn-winter foraging areas are dominated by a greater percentage of grasses than shrubs, but still have a substantial shrub component. Grain fields are also used for winter foraging (5-021).

Adequate cover is among the greatest factors affecting lesser prairie-chicken populations, and the continued loss of shrub/grassland habitat remains the greatest threat to the future of the lesser prairie-chicken. Preserving these shrub/grassland communities and properly managing rangelands can help landowners boost local lesser prairie-chicken populations, as well as populations of other species that rely on similar habitat (5-001).

Credit: Kansas Department of Wildlife and Parks

Suitable habitat for the lesser prairie-chicken has been identified within the Roswell site (see Section 4, Critical and Important Terrestrial Habitat). The BLM Roswell Field Office has included Section 18 of the Roswell site within a designated area of known occupied lesser prairie-chicken habitat. The closest active lek is located approximately 2 miles west of the Roswell site in Section 15; Township 11 South; Range 30 East. There are approximately 10 active or historic leks located within a 5-mile radius of the Roswell site (all of which are located west of Section 18). This area is surveyed annually by the BLM for lek activity in locations where historic lek activity has been monitored and recorded.

5.3.2 Species that Potentially Occur Within the Roswell Site

There are an additional six species (one federally listed endangered and five species of concern) that potentially occur within the Roswell site. Potentially suitable habitat for these species occurs within the Roswell site. A description of these species is presented below.

Northern aplomado falcon (*Falco femoralis septentrionalis*)
The northern aplomado falcon is one of three subspecies of the aplomado falcon and the only subspecies recorded in the United States. The northern aplomado falcon was first listed on February 25, 1986. It is currently designated as endangered throughout their entire range (5-046).

Credit: Glenn Mills/Texas Parks and Wildlife Department

Adults have a buff colored upper breast with broad, blackish flanks usually extending into a band across the breast; the lower breast and undertail feathers are rufous (red). They have a long blackish tail marked with narrow white bands. Wings are dark above with blackish wing linings and white-edged feathers that form a narrow white line on the trailing edges of the wings. The falcon has a bold black and white facial pattern. Cere (nose area), eye-ring, legs, and feet are bright yellow.

Aplomado falcons are most often seen in pairs. They do not build their own nests, but use stick nests built by other birds. Pairs work together to find prey and flush it from cover. Aplomado falcons eat mostly birds and insects. They are fast fliers, and often chase prey animals as they try to escape into dense grass. Parents make 25 to 30 hunting attempts per day in order to feed their young. Chicks are fed six or more times each day. They live up to 20 years in captivity (5-008).

Falcons require open habitats that have scattered trees for hunting, roosting, and nesting and an understory of grass and shrubs. Habitat types include yucca-covered ridges in coastal prairie, riparian woodland in open grassland, palm and oak savannas, deciduous woodland, yucca-mesquite grasslands, and a variety of other open desert grassland and shrub habitats (5-008).

The USFWS has proposed to reintroduce northern aplomado falcons into their historic habitat in southern New Mexico and Arizona with the purpose of establishing a viable resident population. To accomplish this, in 2005 they proposed to release up to 150 captive-raised falcons annually in the summer and/or fall for 10 or more years until a self-sustaining population is established. The release methodology would be similar to that used in Texas during the release of captive-raised aplomado falcons on and around the Laguna Atascosa NWR (5-008). The release of individuals in New Mexico would shift their designation from endangered to nonessential experimental population according to section 10(j) of the ESA.

Habitat for the northern aplomado falcon within the Roswell site is marginal due to the lack of potential perch sites. The area is dominated with low shrubs that provide marginal roost and nest habitat. No individuals or nests were observed during the February 2007 field survey of the Roswell site. It is recommended that prior to any disturbance activities within the Roswell site a comprehensive survey of the area be performed to identify the presence or absence of the northern aplomado falcon using the *Interim Survey Methodology for the Northern Aplomado Falcon (Falco fermoralis septentrionalis) in Desert Grasslands* (5-003).

Baird's sparrow (*Ammodramus bairdii*)

The Baird's sparrow is considered a species of concern and is found in New Mexico between the months of September and May annually for wintering habitat. Little is known about winter range habitat requirements of the Baird's sparrow. Baird's sparrows are consistently seen in areas with dense and expansive grasslands, either solitary or in small numbers with other grassland specialists, including grasshopper sparrow and savannah sparrow (5-020).

Credit: www.oteromesa.org

The Roswell site supports shrub grassland habitats. These habitat types are known to be used annually by the Baird's sparrow as wintering habitat. It is possible for this species to be present in the general geographic area.

Western burrowing owl (*Athene cunicularia hypugaea*)
Burrowing owl nesting habitat consists of open areas with mammal burrows. They use a wide variety of arid and semi-arid environments, with well-drained, level to gently sloping areas characterized by sparse vegetation and bare ground. Breeding habitats include native prairie, tame pasture, hayland, fallow fields, road and railway rights-of-way, and urban habitats (e.g., campuses, airports, and golf courses). Burrowing owls do not occupy all apparently available habitat (i.e., prairie dog or ground squirrel colonies). Unused colonies have been documented in virtually all states within the current range of the burrowing owl.

Credit: Charlene Burge (www.deserttortoise.org)

Burrowing owls require a mammal burrow or natural cavity surrounded by sparse vegetation. Burrow availability is often limiting in areas lacking colonial burrowing rodents. Burrowing owls frequently use burrows of black-tailed prairie dogs. They nest less commonly in the burrows of Douglas' ground squirrels, white-tailed prairie dogs, Gunnison's prairie dogs, yellowbellied marmots, woodchucks, skunks, foxes, coyotes, and nine-banded armadillos. Where mammal burrows are scarce, burrowing owls have been found nesting in natural rock and lava cavities (5-040).

During the 2007 field survey, there was no sign of the western burrowing owl within the Roswell site. The habitat present within the Roswell site would be marginal. There is a known population of western burrowing owl that occurs approximately 35 miles to the west of the Roswell site on the Bitter Lake NWR (5-029).

Black-tailed prairie dog (*Cynomys ludovicianus*)
Black-tailed prairie dogs are a species of concern that live in shortgrass and midgrass prairies and grass-shrub habitats. The black-prairie dog provides a prey base for the listed black-footed ferret and provides nesting habitat for the listed western burrowing owl (5-042). There is a known population of black-tailed prairie dogs that occurs in the Bitter Lake NWR located approximately 35 miles west of the Roswell site (5-029). A small amount of suitable habitat was identified within the Roswell site during the 2007 field survey, but no individuals or colonies were observed during the survey.

Swift fox (*Vulpes velox*)
Habitat for the swift fox, which is a species of concern, includes open prairie and arid plains, including areas intermixed with winter wheat fields. The swift fox has been found to select only shortgrass prairies and had lower-than-expected use or completely avoided non-native grasslands enrolled in the Conservation Reserve Program, irrigated agricultural fields, and dryland agricultural fields (5-043).

Dens of the swift fox occur in burrows, which the species may dig itself or may have been made by another mammal (e.g., marmot, prairie dog, badger), usually in sandy soil on high ground (e.g., hill top) in open prairies, and along fencerows. Individuals may use several different dens throughout the year (5-043).

During the 2007 field survey there was very little grassland or prairie type habitat observed within the Roswell site. Suitability of the habitat present within the Roswell site is marginal for the swift fox.

Townsend's big-eared bat (*Corynorhinus townsendii*)
Townsend's big-eared bat is a species of concern that occurs in a variety of xeric to mesic habitats, including desert scrub, sagebrush, chaparral, deciduous and coniferous forests (including, but not limited to, piñon-juniper, spruce-fir, redwood, mixed hardwood-conifer, and oak woodlands) (5-029).

During the day Townsend's big-eared bats are typically found in caves or mine tunnels, but at night they often rest in abandoned buildings. In summer these bats are widely distributed in New Mexico and can be found over desert-scrub, in shelters in desert-mountains, oak-woodland, piñon-juniper, or coniferous forests (5-029).

Credit: www.ut.blm.gov

There are no caves or mines within or adjacent to the Roswell site that would provide suitable roost habitat for this species. However, it is possible that a transient individual may be observed within the Roswell site and any open water or lights associated with the facility would attract them.

5.3.3 Species that Occur Within the General Geographic Area But Do Not Have Suitable Habitat within the Roswell Site

The following species are known to occur in the general geographic area; however suitable habitat is not known to occur with the Roswell site. For many of the species the closest suitable habitat is located approximately 35 miles west along the Pecos River.

5.3.3.1 Fish

Pecos gambusia (*Gambusia nobilis*)
The Pecos gambusia is a federally listed endangered species. Twelve populations of Pecos gambusia are known to occur near Roswell, New Mexico. Natural populations occur on the Bitter Lake NWR in isolated gypsum sinkholes, and in Sago and Dragonfly Springs, including their outflows which combine to form the perennial portion of the Lost River. Introduced populations occur on Bitter Lake NWR in isolated gypsum sinkholes and on the Salt Creek Wilderness Area in Ink Pot, an isolated gypsum sinkhole. Pecos gambusia presently occurs in Blue Spring, a 2.5-mile spring run that flows into the Black River near Black River Village, New Mexico. The species is found from the spring source to within 164 feet of the waterfall at the confluence with Black River. Also an introduced stock of Pecos gambusia occurs in a series of artificial pools at the Living Desert State Park near Carlsbad, New Mexico. The original source for this population presumably came from Blue Spring in 1975. Pecos gambusia has been extirpated from two historic locations of occurrence in New Mexico, including the Pecos River near Fort Sumner and North Spring River near Roswell (5-015).

There is no suitable habitat for the Pecos gambusia found within or adjacent to the Roswell site. The closest suitable habitat is located approximately 35 miles west of the Roswell site along the Pecos River and within the Bitter Lake NWR.

Pecos bluntnose shiner (*Notropis simus pecosensis*) - Designated Critical Habitat
The Pecos bluntnose shiner is a federally threatened species that is restricted to permanent flowing waters of the Pecos River in New Mexico. The Pecos bluntnose shiner is federally listed as threatened. Critical habitat for this subspecies is designated along two sections of the Pecos River in New Mexico. The first section begins approximately 10 miles south of Fort Sumner, DeBaca County, and extends approximately

64 miles downstream into Chaves County. The second section is between Hagerman and Artesia in Chaves and Eddy Counties and is approximately 37 miles long (5-014).

There is no suitable habitat for the Pecos bluntnose shiner found within or adjacent to the Roswell site. The closest suitable habitat and its designated critical habitat is located approximately 35 miles west of the Roswell site along the Pecos River and within the Bitter Lake NWR.

Greenthroat darter (*Etheostoma lepidum*), Headwater catfish (*Ictalurus lupus*), Pecos pupfish (*Cyprinodon pecosensis*), and Rio Grande shiner (*Notropis jemezanus*)
These four species of fish are listed as species of concern and all require aquatic habitats (5-029). Their preferred habitat ranges from fast moving or swift waters to slow moving meandering rivers or streams of which none is found within the Roswell site. These species are primarily associated with habitats located within the Bitter Lake NWR and along segments of the Pecos River situated approximately 35 miles west of the Roswell site.

5.3.3.2 Birds

A description of the bird species with federal protection is presented below as well as habitat associations for each of the species.

Least tern (interior population) (*Sterna antillarum*)
The least tern (interior population) was listed under ESA as endangered on June 27, 1985 (50 Federal Register 21, 784-21,792) in the following states: Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana (Mississippi River and it's tributaries north of Baton Rouge), Mississippi (Mississippi River), Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Tennessee, and Texas (except within 50 miles of the Gulf Coast). The States of Arkansas, Illinois, Indiana, Iowa, Missouri, Nebraska, Tennessee, Texas, Kansas, Kentucky, New Mexico, Oklahoma, and South Dakota list the interior least tern as endangered under State laws (5-010).

In New Mexico, the least tern has been documented occurring in the Bitter Lake NWR on the Pecos River approximately 35 miles west of the Roswell site. The riverine nesting areas of interior least terns are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting locations usually are at the higher elevations and away from the water's edge because nesting starts when the river flows are high and small amounts of sand are exposed. There is no open water habitat or riverine habitat found within or adjacent to the Roswell site that would provide suitable habitat for the least tern.

Bald eagle (*Haliaeetus leucocephalus*)
The bald eagle was first listed on March 11, 1967 (5-034) as an endangered species. In 1995 its designation was changed to threatened in the lower 48 states (5-033) and in 1999 the bald eagle was proposed for delisting (5-034). Once delisted from the ESA, bald eagles will continue to be protected by the Bald and Golden Eagle Protection Act as amended in 1962 and the Migratory Bird Treaty Act of 1918. Both acts protect bald eagles by prohibiting killing, selling or otherwise harming eagles, their nests or eggs. The Bald and Golden Eagle Protection Act also protects eagles from disturbance.

The breeding range of the bald eagle is associated with aquatic habitats (coastal areas, river, lakes, and reservoirs) along forested shorelines or cliffs in North America. Throughout their range, they select large, super-canopy roost trees that are open and accessible, mostly conifers. They winter primarily in coastal estuaries and river systems of the lower 48 states and Alaska, where thousands of bald eagles migrate each fall to take advantage of salmon-spawning runs.

The bald eagle is described as occupying the entire state of New Mexico; however the Roswell site does not contain suitable nest, roost, or foraging habitat for the bald eagle. The Roswell site may be used as a flyover area, but the absence of suitable habitat would prevent the use of the site by bald eagles.

Mexican spotted owl (*Strix occidentalis lucida*) - Designated Critical Habitat
The Mexican spotted owl was first listed on March 16, 1993. It is currently designated as threatened throughout their entire range.

Habitat characteristics highly sought by Mexican spotted owls include high canopy closure, high stand density, a multi-layered canopy, uneven-aged stands, numerous snags, and downed woody matter. These are best expressed in old-growth mixed-conifer forests (usually more than 200 years old). These characteristics may also develop in younger stands that are unmanaged or minimally managed, especially when the stands contain remnant large trees or patches of large trees from earlier stands. Spotted owls are found in Douglas fir, hemlock-sitka spruce, redwood, ponderosa pine, larch/white pine, lodgepole pine, fir-spruce, aspen/hardwood, and piñon-juniper forest types (5-029). Suitable habitat for the Mexican spotted owl does not occur within or adjacent to the Roswell site. There is no designated critical habitat within or adjacent to the Roswell site.

American peregrine falcon (*Falco peregrinus anatum*) and Arctic peregrine falcon (*Falco peregrinus tundrius*)
Both the American peregrine falcon and the arctic peregrine falcon are considered species of concern and are known to live in mountainous areas, river valleys and along coastlines. These species commonly nest on cliffs, in tree snags, or other elevated areas where they can readily scan for prey. Both the arctic and American peregrine falcons are migratory species that migrate from northern climates (i.e., Alaska and Canada) to warmer winter climates in Central and South America. Important habitat such as cliffs and roost sites are not present for these species within the Roswell site and any individuals observed in the general area would likely be transient individuals during seasonal migration (5-019).

Bell's vireo (*Vireo bellii*)
In New Mexico the Bell's vireo is considered a species of concern and characteristically occurs in dense shrubland or woodland associated with riparian habitats along lowland stream courses, made up primarily of willows (*Salix* spp.), mesquite (*Prosopis* spp.), and seepwillow (*Baccharis glutinosa*). The nest is a cup of grasses and other plant parts, slung between twigs or small stems not far above the ground (5-029). There is no riparian habitat present within the Roswell site; therefore suitable habitat for this species is not present and this species is not anticipated to be directly or indirectly impacted.

Black tern (*Chlidonias niger*)
The black tern is a species of concern that nests in shallow, highly productive wetlands with emergent vegetation in freshwater (and sometimes brackish or alkaline) marshes, along prairie sloughs, lake margins, edges of islands or slow-moving rivers, wet meadows, bogs, and shrub-swamps. In New Mexico the black tern in known to occur in desert riparian areas that occur where desert streams provide sufficient moisture for a narrow band of trees and shrubs along the margins. These habitats occurs at elevations where stream conditions provide sufficient permanent moisture for emergent plants, or for a narrow band of deciduous trees and shrubs; at low elevation these areas are characterized by cottonwood and sycamore, at mid-elevation by white alder (*Alnus rhombifolia*) and bigleaf maple (*Acer macrophyllum*), and at high elevation by willow (5-029). There is no riparian, riverine, or wetland habitat present within the Roswell site; therefore suitable habitat for this species is not present and this species is not anticipated to be directly or indirectly impacted.

Mountain plover (*Charadrius montanus*)
Mountain plover is a species of concern which utilizes shortgrass prairies and dry playas dominated by blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*) and scattered taller vegetation during the breeding season. Other vegetation includes western wheatgrass (*Pascopyrum smithii*), fourwing saltbush (*Atriplex canescens*), rabbitbrush (*Chrysothamnus* spp.), snakeweed (*Gutierrezia sarothrae*), cholla (*Cylindropuntia* spp.), prickly pear (*Opuntia polyacantha*), yucca (*Yucca* spp.) and occasionally juniper (*Juniperus* spp.). In north-central and northwestern New Mexico they occur in basin sagebrush communities. During spring and fall migrations the birds are regularly found on turf farms at Moriarty (Torrance County) and Los Lunas (Valencia County) where varieties of Kentucky bluegrass (*Poa pratensis*) are grown. The species does not require a free water source (5-029).

There is no prairie grassland present within the Roswell site. The grassland habitat that is present is limited to small parcels scattered between shrub habitats. Due to limited grassland habitats present within the Roswell site, the mountain plover is not expected to be directly or indirectly impacted.

Northern goshawk (*Accipiter gentilis*)
The northern goshawk is found in various forest habitat types, including Douglas fir and its common associates such as western hemlock, western redcedar, true firs, redwood, ponderosa pine, and larch. Northern goshawks of New Mexico occur locally in mature, closed-canopied coniferous forests of mountains and high mesas (5-029). There is no forested habitat present within or adjacent to the Roswell site; therefore this species is not anticipated to be directly or indirectly impacted.

Yellow-billed cuckoo (*Coccyzus americanus*)
The western sub-species of the yellow-billed cuckoo is associated with lowland deciduous woodlands, willow and alder thickets, second-growth woods, deserted farmlands, and orchards (5-029). There is no suitable habitat for the yellow-billed cuckoo within or adjacent to the Roswell site. The closest known habitat would be located approximately 35 miles west of the Roswell site along the Pecos River.

5.3.3.3 Mammals

The USFWS identified one ESA listed endangered mammal and five mammalian species of concern within Chaves County. Species information and habitat requirements for these six species are presented below.

Black-footed ferret (*Mustela nigripes*)
The black-footed ferret was first listed on March 11, 1967. It is currently designated as endangered in the entire range, except where listed as an experimental population. Within the area covered by this listing, this species is known to occur in Arizona, Colorado, Montana, South Dakota, Utah, Wyoming, and Chihuahua, Mexico (5-028).

Black-footed ferrets are endangered because much of the shortgrass prairie habitat upon which the ferrets depend has been plowed for crops. Prairie dogs, which are the ferrets' main food, have been reduced in number due to habitat loss and disease. Prairie dogs also have been killed because they eat grass used by livestock or winter wheat grown as a crop.

The black-footed ferret is limited to open habitat, the same habitat used by prairie dogs: grasslands, steppe, and shrub steppe. When the black-footed ferret is inactive, it occupies underground burrows made by prairie dogs. During the 2007 field survey, there were no prairie dog colonies identified as occurring within or adjacent to the extents of the Roswell site. The black-footed ferret relies heavily on prairie dog colonies as a prey base and for shelter. Due to the lack of prey base and associated habitat, these species are not expected to be present within or adjacent to the Roswell site.

Desert pocket gopher (*Geomys arenarius*)
The desert pocket gopher is a species of concern that occurs in loose soils of disturbed areas or sandy areas near open water; it is often common along edges of rivers, ponds, or irrigation canals (5-043). There is no suitable habitat for this species found within or adjacent to the Roswell site. The only water found within the Roswell site is associated with livestock water (i.e., Red Tank). During the 2007 field survey, there was no sign of gopher activity encountered within the Roswell site.

Pecos River muskrat (*Ondatra zibethicus ripensis*)
The Pecos River muskrat is a species of concern that occurs in marshes and drainage ditches along the Rio Grande, Pecos, and San Juan Rivers. There is a known population of muskrats found in the Bitter Lake NWR (5-029). There is no marsh or riparian habitat found within the Roswell site that would support suitable habitat for the Pecos River muskrat. The closest habitat to the Roswell site is located approximately 35 miles west along the Pecos River and the Bitter Lake NWR.

Western red bat (*Lasiurus blossevillii*)
In New Mexico, the western red bat is a species of concern that is associated with riparian communities dominated by deciduous trees (e.g., encinal or riparian sycamores and cottonwoods). The riparian cottonwood forests of the lower Rio Grande and Pecos valleys may support small populations of western red bats. The western red bat is also periodically found in sacatan grassland, sycamore, cottonwood, rabbitbrush, oak savanna, oak woodlands, piñon-juniper woodland, and chaparral woodlands (5-029). There is no riparian habitat or other suitable habitat for the western red bat within the Roswell site.

5.3.3.4 Mollusk/Anthropod-Invertebrate

There are three endangered mollusk species (Roswell springsnail, Pecos assiminea snail, Koster's springsnail), and one endangered arthropod species (Noel's amphipod) that occur within Chaves County. There is also one candidate mollusk species (Texas hornshell) that has been identified as occurring within Chaves County. All five of these species are associated with spring and sinkholes located along the Pecos River and within the Bitter Lake NWR located approximately 35 miles west of the Roswell site.

Noel's amphipod (*Gammarus desperatus*)
Noel's amphipod, which is a federally listed endangered species, is currently known only to occur on Bitter Lake NWR at the Sago Spring wetland complex, Bitter Creek, and along the western boundary of Unit 6 of the refuge. Noel's amphipod appears to be declining at Dragonfly Spring at the headwaters of Bitter Creek following the Sandhill Fire that burned through the area in March 2000 (5-002).

Pecos assiminea snail (*Assiminea pecos*)
Currently the Pecos assiminea snail (federally listed endangered) persists at Diamond Y Spring in Pecos County, Texas. The species also persists at Bitter Lake NWR. In 2000, a previously unknown population was discovered at East Sandia Spring in Reeves County, Texas on private lands under stewardship of The Nature Conservancy. Populations on Bitter Lake NWR currently are found in the upper reaches of Bitter Creek near Dragonfly Spring, the lower end of Bitter Creek near Bitter Lake, the lower reaches of the Sago Spring wetland complex near Sinkhole No. 31, on the western perimeter of Unit 7 of the refuge (very localized), and at a spring in the extreme southwestern corner of Unit 15 on the refuge (5-002).

Roswell springsnail (*Pyrgulopsis roswellensis*)
The Roswell springsnail is a federally listed endangered species that is known to occur in Chaves County. Four populations of Roswell springsnail were known when the species was described in 1987. All of these occurred within Chaves County, and three of them were within Bitter Lake NWR. The fourth population was known from North Spring on the Roswell Country Club grounds. Current distribution of Roswell springsnail appears to be restricted to Bitter Lake NWR. No specimens of Roswell springsnail

have been collected at Roswell Country Club since 1995, and its status there could not be assessed in subsequent years due to lack of access to the site. A survey at the Roswell Country Club in August 2004 indicated that the Roswell springsnail was no longer present. Roswell springsnail persists in Bitter Creek, Sago Spring, Sinkhole No. 31, and along the western boundary of Unit 6 of the refuge (5-002).

Koster's springsnail (*Juturnia kosteri*)
Fossil shells of Koster's springsnail, a federally listed endangered species under ESA, presumably of Pleistocene age, have been collected from North Spring River, South Spring River, Berrendo Creek, and the Pecos River near Roswell. Five populations of Koster's springsnail, all from New Mexico, were known when the species was described in 1987. Four of these populations were on Bitter Lake NWR. The fifth population was known from North Spring on the Roswell Country Club grounds. The current distribution of Koster's springsnail appears to be restricted to Bitter Lake NWR. The status of Koster's springsnail was unknown at the Roswell Country Club following a survey in 1995 due to lack of access to the site; however, in August 2004, the site was resurveyed and this species could not be found. Koster's springsnail persists in Lake St. Francis, Dragonfly Spring, Bitter Creek, Sago Spring, Sinkhole No. 31 on the refuge, the southwestern corner of Unit 15 on the refuge, the northwestern border of Hunter Marsh, and in isolated locations along the western boundaries of Units 5, 6, and 7 on the Bitter Lake NWR (5-002).

Texas hornshell (mussel) (*Popenaias popeii*)
The Texas hornshell is a mollusk species that has been proposed for listing under ESA and is considered a candidate species. Historically, Texas hornshell occurred in the lower Pecos River of New Mexico, downstream throughout the Lower Rio Grande (Brownsville, Texas) and major tributaries in Texas, southward to the Río Pánuco drainage of San Luis Potosí, México. Texas hornshell has declined notably throughout its historic range and now can only be confirmed as extant from one location in each state: in the Black River of New Mexico and the Laredo area of the Rio Grande in Texas (5-018). In New Mexico, this species was common in the lower Pecos River from North Spring River, Roswell, Chaves County, south to Texas, including the Black and Delaware Rivers, Eddy County. Since 1996, a live population of Texas hornshell has been confirmed in the Black River, New Mexico, from Black River Village downstream to the U.S. Highway 285 bridge crossing.

There is no suitable habitat present for these species within the Roswell site. Most of these species are confined to habitats associated with the Bitter Lake NWR and the Pecos River.

5.3.3.5 Plants

There is one endangered plant species (Kuenzler's hedgehog cactus), one threatened plant species (Pecos sunflower), and one plant species that is identified as a species of concern (Wright's marsh thistle), identified by the USFWS as occurring in Chaves County. Habitat characteristics and species information for these three plant species are presented below.

Kuenzler's hedgehog cactus (*Echinocereus fendleri* var. *kuenzleri*)
The Kuenzler's hedgehog cactus was originally listed as endangered in October 1979 (5-012) due to the overwhelming pressure of plant collectors.

Kuenzler's hedgehog cactus occurs primarily on gentle, gravelly to rocky slopes and benches on limestone or limy sandstone, in Great Plains grassland, oak woodland, or piñon-juniper woodland. The species occurs most commonly at elevation from 5,200-6,600 feet (5-013).

Kuenzler's hedgehog cactus was known from a single location on the east slope of the Sacramento Mountains in New Mexico (Chaves and Otero Counties) when listed as endangered in 1979 (5-013). Subsequent field surveys have expanded the Sacramento Mountain east-slope range of this plant 10 miles to the west in Otero County and 40 miles north in Lincoln County. Numerous new locations within this range place it within U.S. Forest Service (USFS) and BLM jurisdictions as well on private and state lands. It has also been found on the west side of the Sacramento Mountains in Lincoln County. In addition, this cactus has been found on USFS and BLM lands in the northern Guadalupe Mountains in Eddy and Otero counties. The range of this cactus extends southeast approximately 100 miles from its northwestern-most location in Lincoln County to its southeastern-most location in the Guadalupe Mountains of Eddy County. Populations are not continuous within this range, but are patchy, scattered, and rare (5-012).

All of the known populations of this species within Chaves County are located in the southwestern corner of the county (5-012). There is no suitable habitat within the Roswell site for Kuenzler's hedgehog cactus and there are no known or documented occurrences of this species within or adjacent to the Roswell site.

Pecos sunflower (*Helianthus paradoxus*)
Pecos sunflower was given threatened species status on October 20, 1999 (5-039). The Pecos sunflower is a wetland plant that grows in areas with permanently saturated soils in the root zone. These are most commonly desert springs and seeps that form wet meadows called cienegas. This sunflower also can occur around the margins of lakes, impoundments and creeks. When Pecos sunflowers grow around lakes or ponds, these are usually impoundments or subsidence areas within natural cienega habitats. The soils of these desert wetlands are typically saline or alkaline because the waters are high in dissolved solids and high rates of evaporation leave deposits of salts, including carbonates, at the soil surface. Soils in these habitats are predominantly silty clays or fine sands with high organic matter content. There are no wetlands or riparian habitats within the Roswell site that would provide suitable habitat for the Pecos sunflower.

Wright's marsh thistle (*Cirsium wrightii*)
As indicated by the name the Wright's marsh thistle, a species of concern is associated with wet, alkaline soils in spring seeps and marshy edges of streams and ponds (3,450-8,500 feet). The closest known population is located along the Pecos River approximately 35 miles west of the Roswell site (5-044). There are no wetlands or riparian habitats within the Roswell site that would provide suitable habitat for the Wright's marsh thistle.

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*Indicates those considered, but not cited.

CONTENTS

FIGURES

TABLES

6. REGIONAL DEMOGRAPHY

This section describes key social and economic characteristics of communities and counties surrounding the Roswell site. The objective is to provide descriptions of the socioeconomic characteristics of the area surrounding the site in order to provide information for the site selection process and support environmental impact analysis should the Roswell site be selected for further study.

In general this demographics discussion draws on data derived from a Region of Influence (ROI). The ROI is defined as that region where "the potential has been identified for adverse environmental impacts" related to GNEP facilities. In the absence of a conceptual design for GNEP facilities and a corresponding analysis of adverse impacts, the ROI for this report is defined as the 32-kilometer (20-mile) and 80-kilometer (50-mile) radius around the Roswell site. When data were presented on the county level, the ROI was defined as Chaves, Eddy, Lea, and Roosevelt Counties. County level data are used primarily in subsections 6.3, 6.4, 6.7, and 6.9.

The key economic variables presented in this section are: population statistics, labor force estimates, and social/public services; schools, law enforcement, fire/emergency services, and medical facilities. The section also summarizes local infrastructure, roads, airports, and the availability of public utilities. Additionally, regional housing is discussed in terms of total number of units, occupancy rates, and values.

6.1 Overview and Summary

The Roswell site is located in the sparsely populated arid high desert ranchland of eastern New Mexico (Figure 1-3). The results of the demographic evaluation are summarized below:

- This region is sparsely populated, less than 0.1 people per square mile within 20 miles of the Roswell site, with the vast majority of the population found in urban areas located more than 40 miles from the Roswell site. The average population density within 50 miles of the Roswell site is less than 12 people per square mile;
- Minority populations within 50 miles of the Roswell site are located in parts of Roswell and Dexter (in Chaves County), Artesia (in Eddy County), and Lovington (in Lea County);
- Low-income populations within 50 miles of the Roswell site are located in parts of Roswell and Hagerman (in Chaves County), Artesia (in Eddy County), and Lovington (in Lea County);
- Overall population within 50 miles has remained relatively stable and is generally projected to remain near current levels or increase slightly over the next 20 years;
- The most prominent area of employment is in the agriculture, forestry, fishing, hunting, and mining sector, the unemployment rate is below the national average, the employment growth rate is above the national average;
- Much of the land in this region is private ranchland or is owned and/or administered by federal and state agencies which support numerous recreational areas throughout southeastern New Mexico; and
- Social services and public facilities are concentrated in the more populated cities.

6.2 Population Distribution, Composition, and Projected Growth

This section summarizes the demographics of the region surrounding the Roswell site. Topics include identification of jurisdictions fully or partially within the 50-mile ROI as well as the population distribution, composition, and trends throughout that region.

6.2.1 City, Town, and County Population

The Roswell site is located in the sparsely populated ranchland of eastern Chaves County, approximately 40 miles east of Roswell. Based on the 2000 Census block group data, it is estimated that 91,713 people live within 50 miles of the Roswell site (6-011). Figure 6-1 shows all jurisdictions fully or partially within 50 miles of the Roswell site and is based on the 50-mile base map using data described in Section 1, Maps/Location. Table 6-1 presents the 2000 Census population and the 2005 estimated population for each of the jurisdictions fully or partially within 50 miles of the Roswell site. As of the 2000 Census the total population of all counties fully or partially within 50 miles of the Roswell site was 199,861 (6-006). Therefore, approximately 46 percent of the population in the counties listed in Table 6-1 live within 50 miles of the Roswell site.

Table 6-1. Population of jurisdictions fully or partially within 50 miles of the Roswell site (6-004, 6-006, 6-009).

County	Incorporated City/Town	Census 2000 Population	2005 Population Estimate
Chaves	-	61,382	62,203
-	Roswell	45,293	45,199
-	Dexter	1,235	1,230
-	Hagerman	1,168	1,162
-	Lake Arthur	432	432
Eddy	-	51,658	52,167
-	Artesia	10,692	10,481
Lea	-	55,511	57,006
-	Tatum	683	693
-	Lovington	9,471	9,603
Roosevelt	-	18,018	18,771
-	Elida	183	178
De Baca	-	2,240	2,256
Cochran (TX)	-	3,730	3,578
Yoakum (TX)	-	7,322	7,221

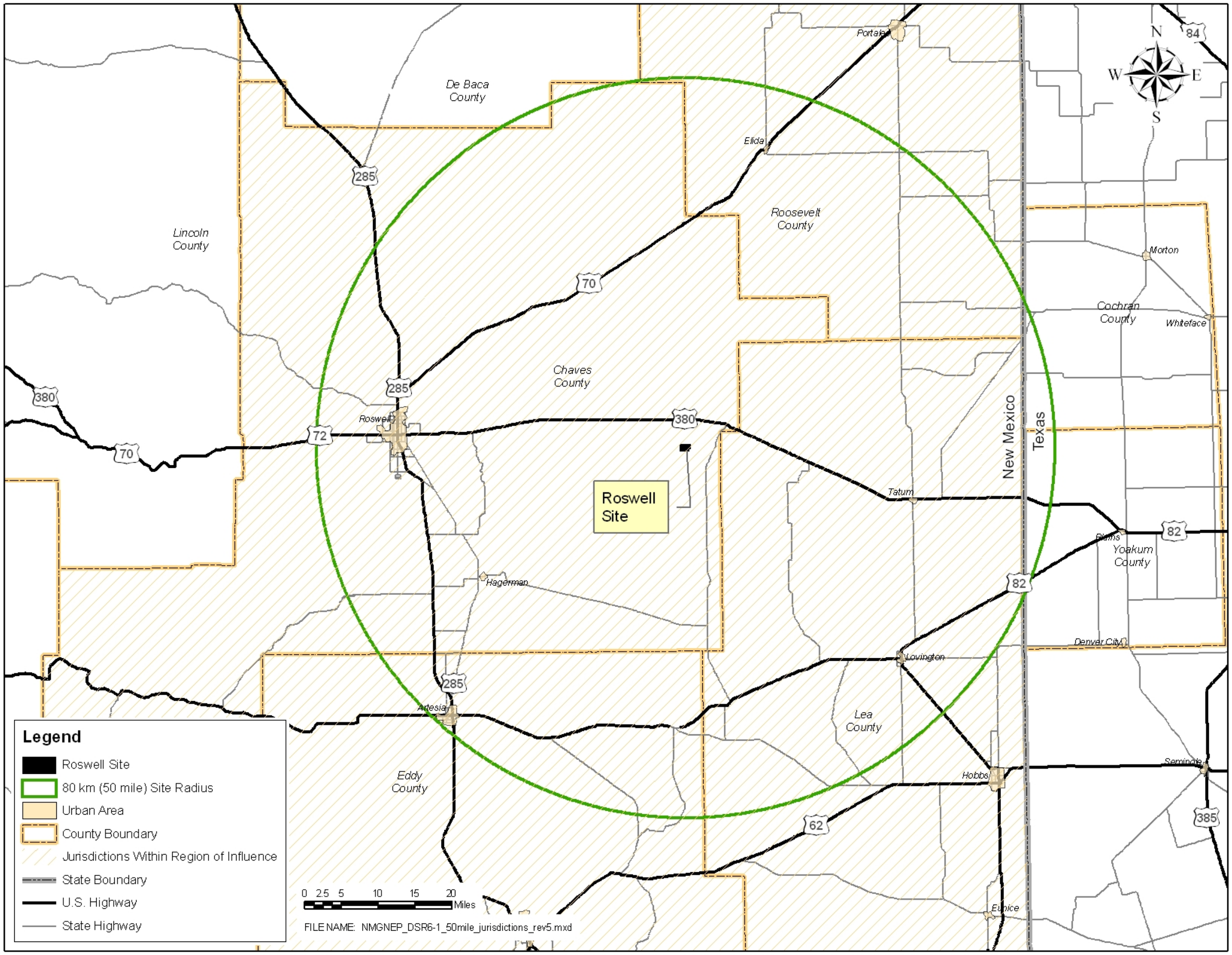

Figure 6-1. Jurisdictions that fall within the 50-mile ROI around the Roswell site (6-043).

6.2.2 Composition of Minority Persons and Households below Poverty Line Within 50 Miles of the Roswell Site

To identify minority and low-income communities within 50 miles of the Roswell site, census data were analyzed on the block group level. Block groups where the percentage of minority or low-income residents are at least 10 percent greater than state averages were considered minority or low-income communities.

The average minority population in New Mexico as of the 2000 Census was 55.3 percent. Therefore, block groups with a minority population of 65.3 percent or greater were considered minority areas (6-006). During the 2000 Census, there were a total of 83 New Mexico census block groups fully or partially within 50 miles of the Roswell site (6-006). A total of 15 block groups within 50 miles of the Roswell site had minority populations that were at least 10 percent greater than the state average. These minority census block groups were located in Roswell and Dexter (in Chaves County), Artesia (in Eddy County), and Lovington (in Lea County) and are shown on Figure 6-2 (6-006).

The low-income population (households below the poverty line) in New Mexico as of the 2000 Census was 18.4 percent. Therefore, New Mexico block groups with a low-income population of 28.4 percent or greater were considered low-income areas (6-006). A total of 18 block groups had low-income populations that were at least 10 percent greater than the state average. The low-income census block groups were located in Roswell and Hagerman (in Chaves County), Artesia (in Eddy County), and Lovington (in Lea County) and are shown on Figure 6-3.

Two census block groups within 50 miles of the Roswell site were located in Texas. The average minority population in Texas as of the 2000 Census was 47.6 percent (6-006). Block groups in Texas with a minority population of at least 57.6 percent were considered minority areas in Texas. The low-income population in Texas as of the 2000 Census was 15.4 percent (6-006). Therefore, block groups with a low-income population of at least 25.4 percent were considered low-income areas in Texas. Neither of the Texas census block groups within 50 miles of the Roswell site was considered minority or low-income areas.

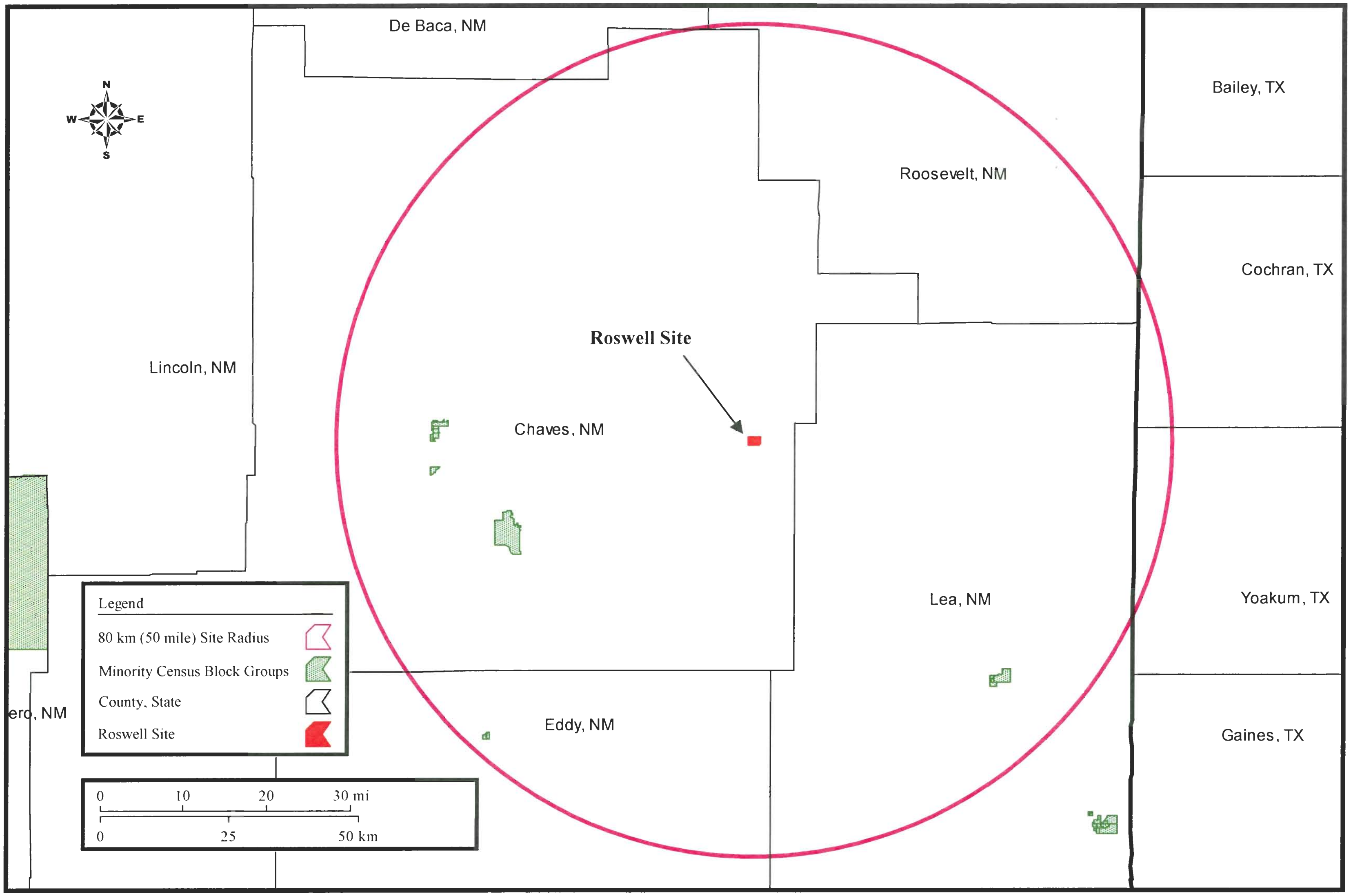

Figure 6-2. Minority census block groups within the 50-mile ROI around the Roswell site (6-006).

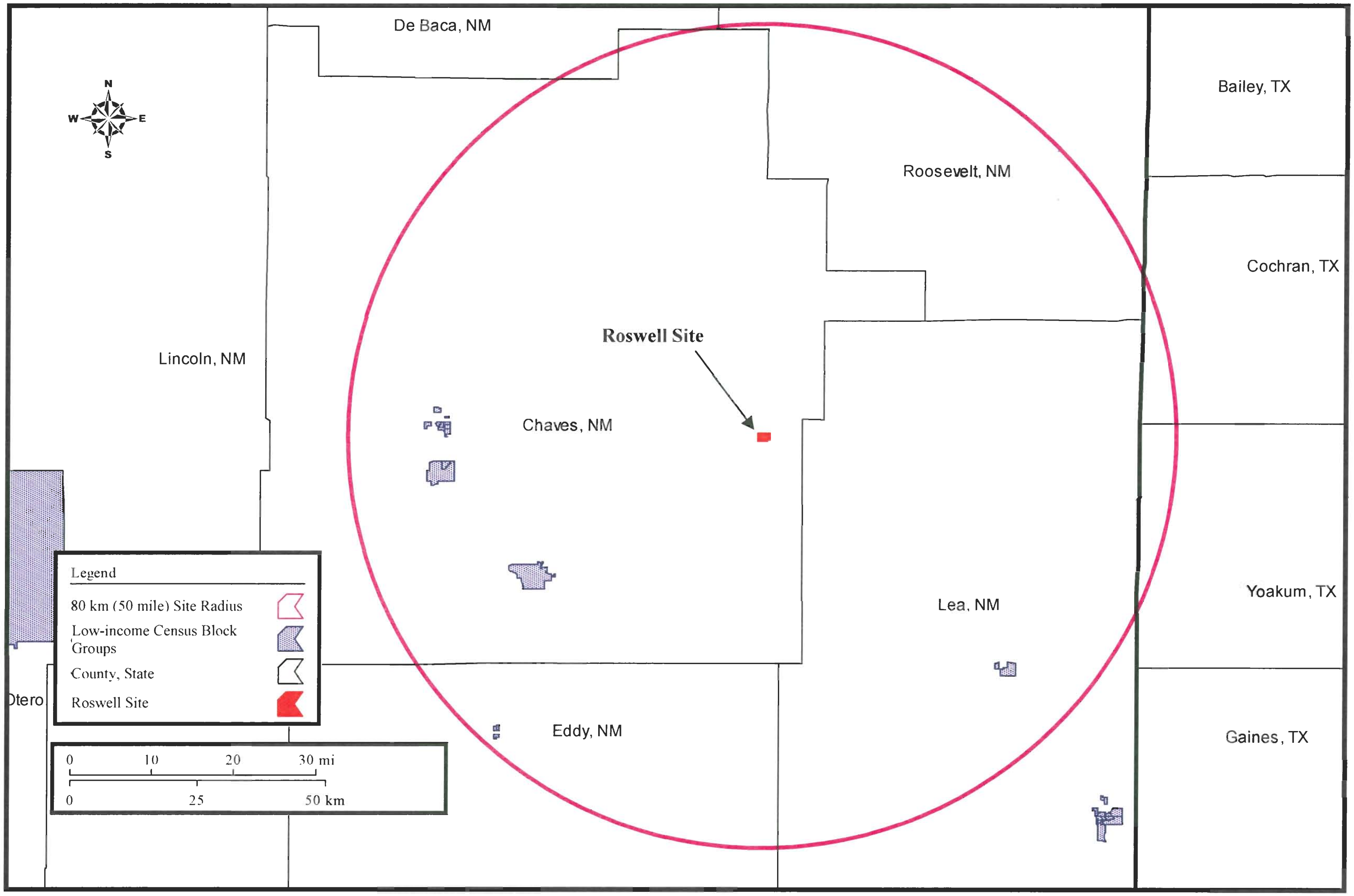

Figure 6-3. Low-income census block groups within the 50-mile ROI around the Roswell site (6-006).

6.2.3 Population Trends

As shown in Figure 6-4, the population in counties fully or partially within 50 miles of the Roswell site remained relatively stable from 2000 to 2005 (6-004, 6-009). The majority of the population in these counties is from Chaves, Eddy and Lea Counties. Figure 6-5 shows the projected population growth (2010 to 2030) for the counties fully or partially within 50 miles of the Roswell site (6-004, 6-008). The population of Lea County is projected to decrease slightly while the populations of all other counties within 50 miles of the Roswell site are projected to remain stable or increase by 2030.

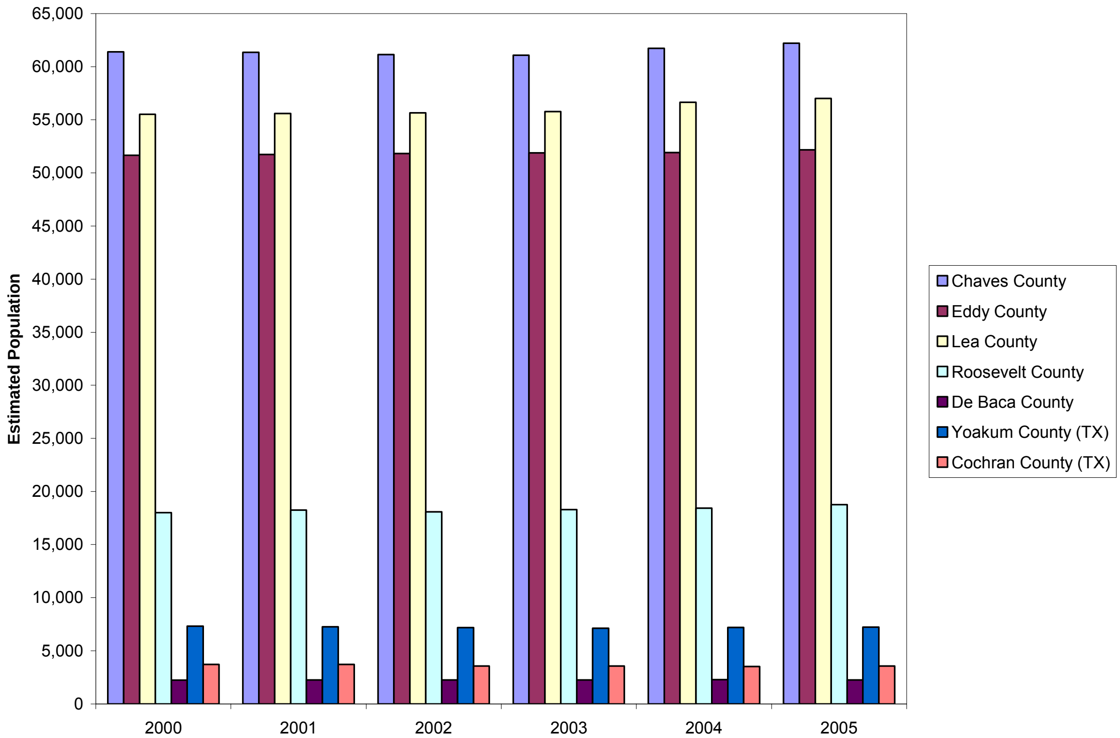

Figure 6-4. Estimated population of counties fully or partially within the 50-mile ROI around the Roswell site (2000 to 2005). (6-004, 6-009)

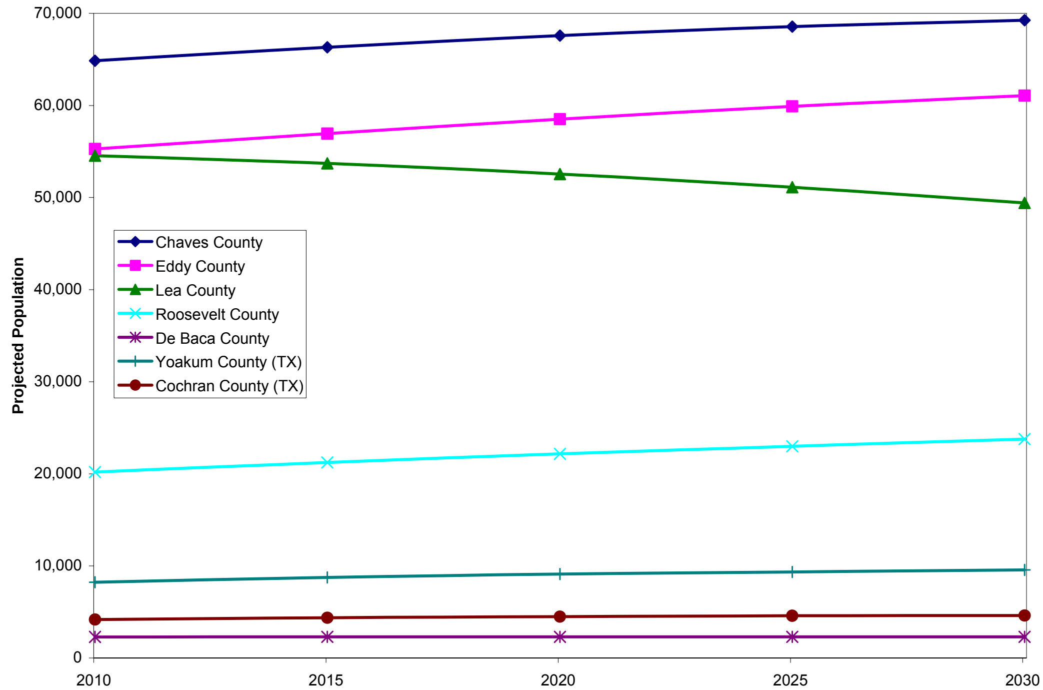

Figure 6-5. Projected population of counties fully or partially within the 50-mile ROI around the Roswell site (2010 to 2030) (6-004, 6-008).

6.3 Regional Economic Base

This subsection presents economic data describing the regional labor force and unemployment levels, and summarizes the future economic outlook. Economic data are primarily reported on the county level; therefore, county level data for the ROI were used for the economic analysis.

6.3.1 Total Regional Labor Force

Table 6-2 presents the total regional labor force, according to the 2000 Census, broken down into individual employment sectors. Chaves County has the largest workforce in the ROI followed by Eddy, Lea, and Roosevelt counties. A summary of the regional construction industry and construction workforce according to the County Business Patterns Report (6-007) is presented in Table 6-3. In 2004, there were 400 construction businesses in the region employing a total of over 3,300 workers with a total payroll of over 93.5 million dollars.

Table 6-2. Total regional labor force (2000) (6-006).

Sector	Chaves County	Lea County	Roosevelt County	Eddy County	Total Regional Labor Force
Agriculture, forestry, fishing, hunting, and mining	2,275	4,188	842	2,941	10,246
Construction	1,575	1,268	414	1,413	4,670
Manufacturing	2,226	715	366	1,279	4,586
Wholesale trade	700	658	144	515	2,017
Retail trade	2,938	2,418	950	2,753	9,059
Transportation and warehousing, and utilities	1,216	1,347	358	1,090	4,011
Information	408	227	263	348	1,246
Finance, insurance, real estate, and rental and leasing	1,154	642	351	873	3,020
Professional, scientific, management, administrative, and waste management services	1,449	918	246	1,538	4,151
Educational, health, and social services	4,891	4,173	2,263	3,720	15,047
Arts, entertainment, recreation, accommodation, and food services	1,899	1,327	448	1,619	5,293
Other services (except public administration)	1,214	1,343	335	1,408	4,300
Public administration	1,083	1,030	470	1,094	3,677
Total Labor Force	23,028	20,254	7,450	20,591	71,323

Table 6-3. Regional construction industry and labor force (2004) (6-007).

	Chaves County	Lea County	Roosevelt County	Eddy County	Total Region
Total Construction Industry Employees	921	1,133	341	942	3,337
Total Businesses	119	116	54	111	400
Businesses w/ 1-4 Employees	70	62	34	65	231
Businesses w/ 5-9 Employees	23	31	10	15	79
Businesses w/ 10-19 Employees	14	11	5	16	46
Businesses w/ 20-49 Employees	11	9	5	12	37
Businesses w/ 50-99 Employees	1	1	0	3	5
Businesses w/ 100-249 Employees	0	2	0	0	2
Businesses w/ 250+ Employees	0	0	0	0	0
Total Annual Payroll ($1,000)	23,905	35,669	6,488	27,453	93,515

6.3.2 Unemployment Levels

The unemployment level in the ROI for 2006 was 3.9 percent. This level was below the New Mexico average of 4.3 percent and the national unemployment average of 4.6 percent for 2006 (6-003). Table 6-4 lists the civilian labor force, unemployed labor force and the unemployment rates for each of the counties in the ROI.

Table 6-4. Unemployment levels (2006) (6-003).

County	Civilian Labor Force	Unemployed	Unemployment Rate (%)
Chaves County	26,982	1,272	4.7
Eddy County	25,433	981	3.9
Lea County	27,406	926	3.4
Roosevelt County	9,680	347	3.4
Total ROI	89,501	3,506	3.9

6.3.3 Future Economic Outlook

The New Mexico economy is expected to generate about 158,000 new jobs from 2002 to 2012. This represents growth of about 20 percent (an average of approximately 2 percent per year), faster than the projected national increase of 14.8 percent over the same 10-year period (6-029). Employment growth for the ROI from 2003 to 2006 has averaged 1.6 to 4.6 percent per year and is summarized in Table 6-5 (6-034).

Table 6-5. Employment growth (2003 to 2006) (6-034).

County	2003 (%)	2004 (%)	2005 (%)	2006 (%)	Average (2003 to 2006)
Chaves	-0.4	1.4	2.7	2.7	1.6
Eddy	1.0	1.5	3.1	2.6	2.1
Lea	3.0	3.9	6.4	5.2	4.6
Roosevelt	3.1	3.7	0.3	0.3	1.9

6.4 Housing Information

This subsection presents housing information data describing the regional sales and rental markets, and trends in housing additions within the ROI around the Roswell site. Housing data are primarily reported on the county level; therefore, county level data for the ROI were used for the housing analysis. Based on the 2000 Census, there are approximately 79,047 housing units within the four county ROI (6-006). A comparison of the housing statistics in the ROI is presented below.

6.4.1 Regional Sales and Rental Markets

The total housing units and vacancy rates per county for each of the four counties in the ROI is reported for the year 2000 in Table 6-6 (6-006).

Table 6-6. Regional housing sales and rental markets (2000) (6-006).

County	Total Housing Units	Owner Occupied Units (%)	Vacant Units	Rental Vacancy Rate (%)	Homeowner Vacancy Rate (%)	Seasonal / Recreational Units (%)
Chaves	25,647	70.9	3,086	13.5	3.0	1.0
Lea	23,405	72.6	3,706	18.7	3.6	0.5
Roosevelt	7,746	62.7	1,107	11.7	3.6	0.3
Eddy	22,249	74.3	2,870	18.1	2.9	1.3
Total in ROI	79,047	-	10,769	-	-	-

The 2000 Census reports that the median value of owner occupied units in the four counties ranges from a low of $50,100 (Lea County) to $64,200 (Eddy County) with greater than 75 percent of all owner occupied units valued at below $100,000. Of the renter occupied units within the four counties, 82 to 86 percent of gross rents were below $750 per month.

6.4.2 Trends in Housing Units

The number of new housing permits for each county in the ROI from 2000 to 2005 is presented in Table 6-7. In general, from 2000 to 2005, there was a substantial increase in the number of single-family new house construction building permits issued by counties in the ROI. Data from the ROI, which show a modest increase in total numbers of units available, are presented in Table 6-8.

Table 6-7. Building permits issued 2000-2005 by county (6-032).

	Single-family new house construction building permits by Year					
County	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Chaves	30	27	29	55	52	78
Lea	2	10	12	29	47	45
Roosevelt	13	12	14	29	17	23
Eddy	31	40	53	67	65	85
Total in ROI	76	89	108	180	181	231

Table 6-8. Change in available units (6-032).

County	**Total Housing Units (2000)**	**Total Housing Units (2005)**	**Percent Change 2000 to 2005**
Chaves	25,647	25,938	1.1
Lea	23,405	23,859	1.9
Roosevelt	7,746	8,049	3.9
Eddy	22,249	22,646	1.8
Total in ROI	79,047	80,492	-

6.5 Educational Systems in the Region

Educational data are compiled both at the school level and at the district level. Data in the following section are identified either from schools that fall within the 50-mile ROI around the Roswell site or the school districts in Chaves, Lea, Roosevelt and Eddy Counties that fall partially within the ROI. There are nine public school districts that have schools that fall within the ROI, namely:

- Artesia Public Schools District in Eddy County,
- Lovington Public Schools and Tatum Municipal Schools in Lea County,
- Elida Municipal Schools and Dora Consolidated Schools in Roosevelt County, and
- Roswell Independent, Hagerman Municipal, Lake Arthur Municipal, and Dexter Consolidated School Districts in Chaves County.

During the 2004-2005 school year, the 50-mile radius surrounding the Roswell site contained 58 public schools: 29 primary schools, 12 middle schools, 14 high schools, and two other schools. Figure 6-6 shows school districts and schools fully or partially within 50 miles of the Roswell site and is based on the 50-mile base map using data described in Section 1, Maps, in addition to data on the schools and school districts (6-024, 6-025). In addition, there are six private schools within the ROI. The private schools are all in the Roswell area.

6.5.1 Present Capacity

Table 6-9 presents a breakdown of students within the ROI for the 2000-2001 and 2004-2005 school years. The total enrollment in public schools during the 2004-2005 school year was 18,159 students. Private school total enrollment during the 2003-2004 school year was 512 students ranging from pre-kindergarten to 12th grade in six private schools in Chaves County (6-001).

Schools are classified in categories that range from *Large Town* (16 schools) and *Small Town* (19 schools) to *Rural, outside a Census Based Statistical Area* (23 schools) (6-001). In the ROI schools, 323 of the 18,159 students (1.8 percent) enrolled during the 2004-2005 school year were classified as migrant students (children of migrant families) (6-001). Dropout rates in schools within 50 miles of the Roswell site during the 2002-2003 and school year are presented in Table 6-10 (6-027).

Two schools within 50 miles of the Roswell site, Eastern New Mexico University – Roswell Campus and the New Mexico Military Institute, offer post-secondary education. The two schools have a combined enrollment of 4,712 according to Fall 2005 enrollment data (6-001). Both schools are public 2-year colleges. Both schools offer on-campus living quarters for students (6-001).

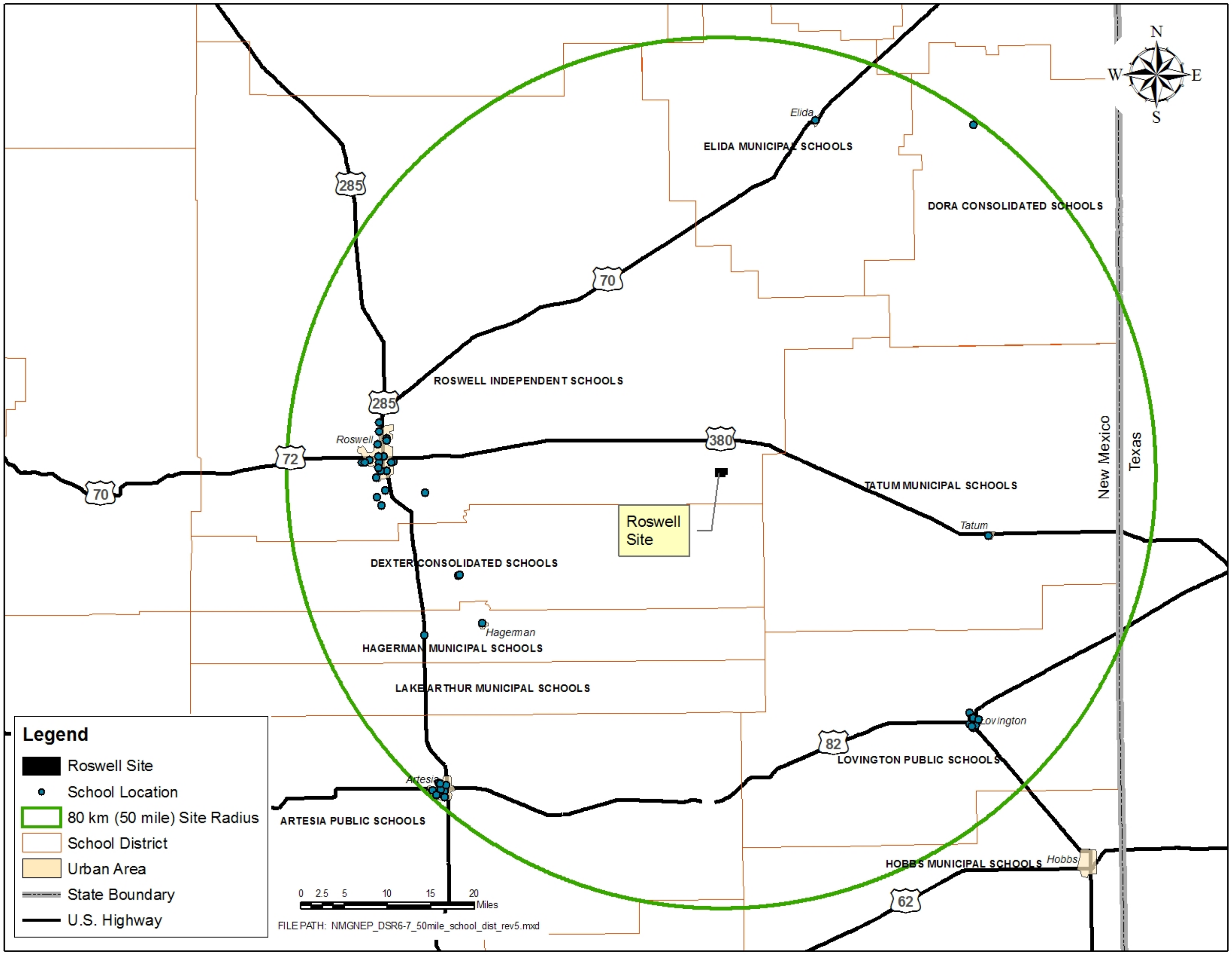

Figure 6-6. School districts and schools within 50 miles of the Roswell site (6-043).

Table 6-9. Public school enrollment (6-001).

	Public Schools Enrolled Students	
	2000-2001	2004-2005
Pre-kindergarten	399	481
Kindergarten	1,227	1,328
Elementary (grades 1-6)	8,664	8,021
Secondary (grades 7-12)	8,863	8,329
Total	19,153	18,159

Table 6.10. Dropout rates for Grades 9-12 in the ROI educational districts 2002-2003 (6-027).

District	Dropouts	Enrollment Grades 9-12	Dropout Rate (%)
Artesia	7	1,042	0.7
Lovington	37	808	4.6
Tatum	3	103	2.9
Dora	0	63	0.0
Elida	0	40	0.0
Roswell	96	2,765	3.5
Hagerman	2	128	1.6
Lake Arthur	5	49	10.2
Dexter	2	350	0.6

6.5.2 Projected Capacity

Enrollment in schools has decreased by approximately 11.9 percent from the 1993-1994 year to the 2003-2004 school year compared with the average enrollment growth in New Mexico schools of 0.2 percent over the same time period. According to the Projections of Education Statistics to 2015, statewide pre-K to 12 enrollment is expected to decrease slightly (-0.3 percent) (6-001).

6.5.3 Percentage of Utilization

The pupil teacher ratio for schools within the ROI averaged 14 to 1 (14.2 for primary, 14.4 for middle, and 13.9 for high school). In 2003-2004, the national pupil-teacher ratio was about 16 to 1 (15.9 for primary, 15.8 for middle, and 15.4 for high school) (6-001).

The average enrollment for schools within the ROI was 278 students per school in primary schools, 346 in middle schools, and 395 in high schools. In 2003–04, the nationwide average number of students per school was 438 in primary schools, 616 in middle schools, and 758 in high schools (6-001).

There were more than 50,000 Title I eligible schools nationally in 2003–04, and these schools accounted for about 50 percent of all students. Within the ROI, there were 39 Title I eligible schools accounting for approximately 66 percent of all students (6-001).

6.6 Recreational Facilities and Opportunities

Recreational areas, administered by various federal and state agencies, are located throughout the southeast area of New Mexico and offer a variety of outdoor recreational activities including camping, hiking, fishing, diving, water sports, fishing, off-road vehicles, and scenic views. Figure 6-7 summarizes public lands in the 50-mile ROI around the Roswell site.

Public areas in southeastern Mew Mexico include National and State parks and monuments, county facilities and historic preservation areas. Other recreational facilities include Mescalero Sands North Dunes Off-Highway Vehicle (OHV) Area (located approximately 2 miles north of the Roswell site), Avalon Reservoir, Bitter Lake NWR, Black River Recreation Area, Bottomless Lakes State Park, Brantley Lake State Park, Carlsbad Wilderness, Dexter National Fish Hatchery, Fort Sumner State Monument, Green Meadow Lake State Fishing Area, Grulla National Wildlife Refuge, Guadalupe Back Country Byway, Haystack Mountain OHV Area, Living Desert Zoo and Gardens State Park, Oasis State Park, Rio Bonito Petroglyph National Recreation Trail, Salt Creek Wilderness, Sitting Bull Falls Day Use Area, Lincoln, Two Rivers Dam, and W.S. Huey Waterfowl Area (6-023).

The National Park Service administers Carlsbad Caverns and White Sands National Monument, the two National Parks in southeastern New Mexico. The National Park Service projections indicate a decrease of 3.5 to 4.4 percent in 2007 visitations from visitations during 2006 (6-021).

Theatres, auditoriums, and concert halls are centered in populated areas including Roswell. Table 6-11 summarizes the 1997 and 2002 Economic Census Survey of Arts, Entertainment and Recreation throughout the four counties of the ROI (6-022, 6-032).

Table 6-11. Recreational facilities and opportunities in southeast New Mexico (6-022, 6-031).

Type of Facility	Number of Facilities (1997)	Number of Facilities (2002)
Total Establishments -Arts Entertainment and Recreation	34	28
Performing Arts and Spectator Sports and related	-	2
Amusement and Gambling	15	6
Other Recreation (golfing, skiing, fitness, bowling)	5	6

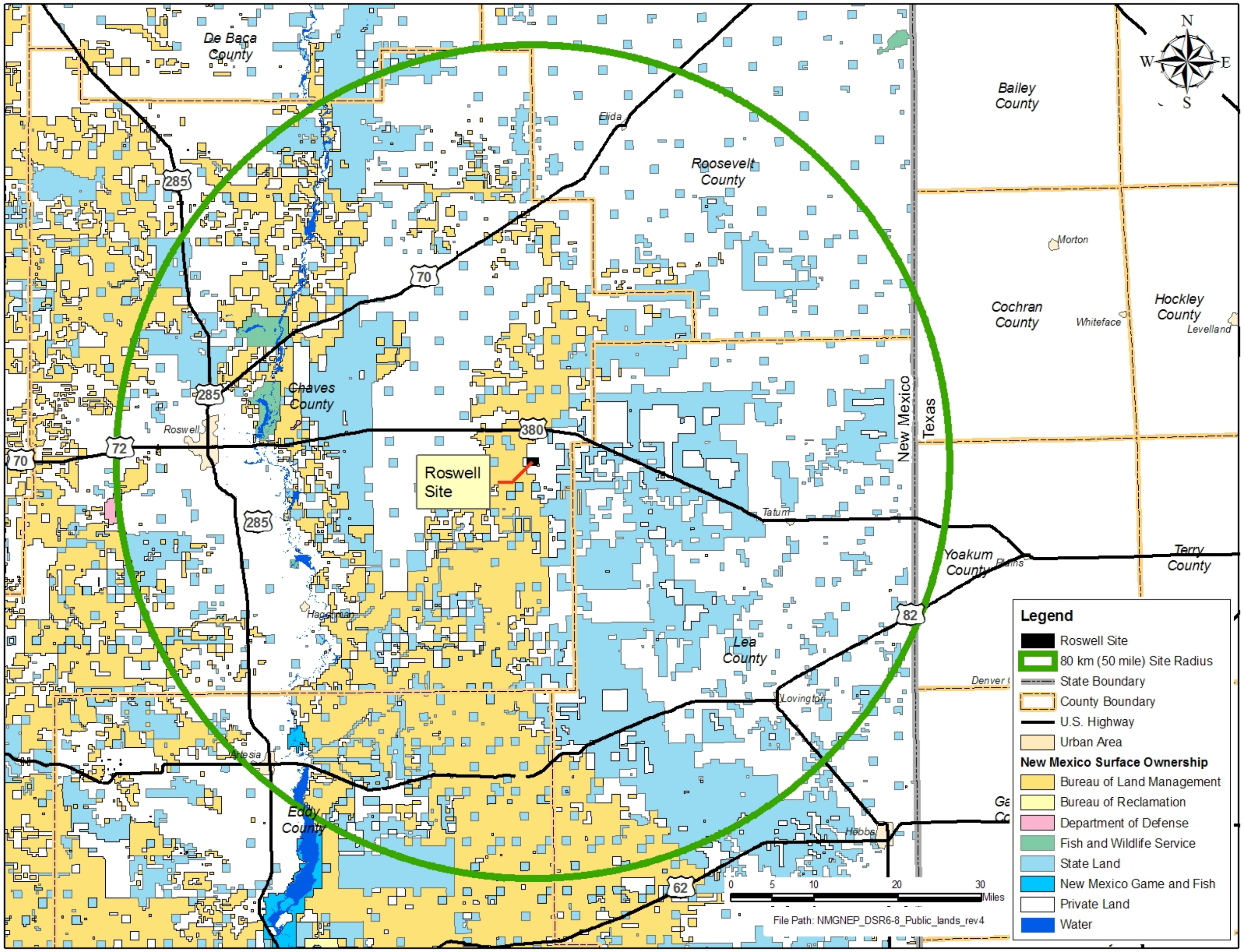

Figure 6-7. Public lands in southeastern New Mexico (6-043, 6-044).

6.7 Taxes

This subsection provides tax information including the regional tax structure, and distribution of current revenues. The New Mexico Department of Taxation and Revenue implements the taxation policies and incentives necessary to fund state programs. Several types of state and local taxes are imposed within the ROI. Applicable tax types include: personal income, gross receipts, compensating, corporate income, corporate franchise, property, severance, and workers compensation tax (6-036).

6.7.1 State Tax Structure

Personal Income Tax

New Mexico imposes a tax on the net income of every resident. Residents are taxed on the net income from employment, unearned income, gambling, pensions, annuities, and income from real or personal property in New Mexico or from businesses located in New Mexico. Non-residents are taxed on the net income from property, employment or business in New Mexico. New Mexico's personal income tax "piggybacks" on the federal return, using the federal adjusted gross income figure as its base. Net income usually equals federal taxable income, although some special deductions are available. New Mexico uses the same dollar amounts as the federal government for personal exemptions, standard deductions and itemized deductions.

Gross Receipts Tax

New Mexico does not have a sales tax. Instead, it has a 5 percent gross receipts tax. In almost every case, the business passes along the tax to the consumer, so that the gross receipts tax resembles a sales tax. Counties and cities also impose gross receipts taxes. The total gross receipts rate is a combination of all rates imposed by the state, counties and municipalities.

The combined gross receipts tax rate varies throughout the state from 5.125 to 7.875 percent. The gross receipt tax in the ROI currently ranges from a low of 5.375 percent in parts of Lea County to 7 percent in Roswell (6-028).

Beginning January 1, 2005, New Mexicans no longer pay taxes on most food purchases. Also beginning January 1, 2005, the State eliminated the tax on certain medical services.

Compensating Tax

The compensating tax is a companion tax to the gross receipts tax. It is a "use" tax that is typically levied on the purchaser of the product or service for using tangible property in the state. The tax applies to imports of factory and office equipment, and other items. It is also used to enforce the conditions of many of the gross receipts tax deductions.

The compensating tax rate is 5 percent of the value of the property or service at the time of acquisition or introduction into New Mexico, or at the time of conversion to taxable use, whichever is later. Compensating tax is imposed on persons using property, and in some cases, services, in New Mexico on which tax has not been paid to New Mexico or any other state. The tax "compensates" for the absence of a gross receipts tax on the purchase of property for use and is intended to protect New Mexico businesses from unfair competition; hence its name.

Corporate Income Tax
Corporate income tax is imposed only on the net income of domestic corporations or foreign corporations' business within the state or from the state, or deriving income from property or employment within this state. The corporate income tax piggybacks onto the Internal Revenue Code. The rates, based on federal taxable income rates, are:

- Up to $500,000: 4.8 percent,
- $500,000 to $1 million: $24,000, +6.4 percent over $500,000, and
- $1 million plus: $56,000, +7.5 percent over $1 million.

Corporate Franchise Tax Fee
A uniform fee of $50 per corporation is levied annually. The franchise tax is imposed on each corporation included in the combined unitary or the consolidated tax returns if the corporation exercises its corporate franchise in New Mexico whether or not income tax is due. The requirement to file and pay the franchise tax also falls on anyone who files a federal S-corporation return.

Property Tax
New Mexico's property taxes are among the lowest in the country. The median value of an owner-occupied property in New Mexico is approximately $108,000. The statewide average property tax on a property assessed at $108,000 is approximately $900. Taxes on a property with a $100,000 market value in 2003 were about $1,000 in Albuquerque, falling to about $260 in rural parts of the state.

Severance Taxes
New Mexico taxes the extraction of minerals from its soil from a series of taxes, generically called severance taxes. The two main groups are: 1) taxes on oil, natural gas, liquid hydrocarbons and carbon dioxide, and 2) taxes on hard-rock minerals, including copper and coal. Of the two groups, the oil and gas taxes account for over 90 percent of the revenues from severance taxes.

Worker's Compensation Tax Fee
This fee is collected by the Taxation and Revenue Department on behalf of the Worker's Compensation Administration. Fees are $4.30 per quarter for every employee at end of quarter; $2 from employee via withholding plus $2.30 from employer.

6.7.2 Local Tax Structure

Counties and municipalities impose varying gross receipts and property taxes. Table 6-12 presents current tax rates for counties within the region and municipalities within those counties (6-039). Table 6-13 presents 2006 property tax rates for counties in the ROI (6-040).

Table 6-12. January-June 2007 gross receipts tax rates in ROI (6-039).

County	Municipality or County	Rate (%)
Chaves	Dexter	6.8125
	Hagerman	7.00
	Lake Arthur	6.3125
	Roswell	7.00
	Remainder of County	5.9375
Eddy	Artesia	6.8125
	Carlsbad	6.8125
	Hope	6.50
	Loving	6.6875
	Remainder of County	5.625
Lea	Eunice	6.6875
	Hobbs	6.6875
	Jal	6.6875
	Lovington	6.625
	Lovington Industrial Park	5.375
	Tatum	6.6875
	Remainder of County	5.375
Roosevelt	Causey	6.5625
	Dora	6.8125
	Elida	7.375
	Floyd	6.5625
	Portales	7.625
	Remainder of County	6.0625

Table 6-13. 2006 Property tax rates in ROI (Mils per $1,000 Value) (6-040).

County	Residential	Non-Residential
Chaves	24.455	26.443
Eddy	20.047	19.681
Lea	26.483	27.258
Roosevelt	23.758	21.059

6.7.3 Distribution of Present Revenues

Taxes are distributed to the New Mexico general fund with dollars collected in New Mexico supporting the following programs: public schools, health and human services, public safety programs, institutions of higher education, local governments, and state and local road funds. In 2005, New Mexico as a whole ranked 20th in taxes collected per capita (6-031). Figure 6-8 shows the percentage of distribution for the 2004 General Fund. Revenue sources for New Mexico are summarized in Table 6-14. A summary of the New Mexico tax growth rate from 1998 to 2002 is shown in Table 6-15.

New Mexico redistributes revenues to counties and municipalities with the goal of equalizing local revenues from the gross receipts tax based on a ratio of population to receipts. Table 6-16 shows Fiscal Year 2005-2006 net receipts, equalization targets based on the ratio, and additional amounts distributed in September, 2006, if any, to counties in the ROI (6-041).

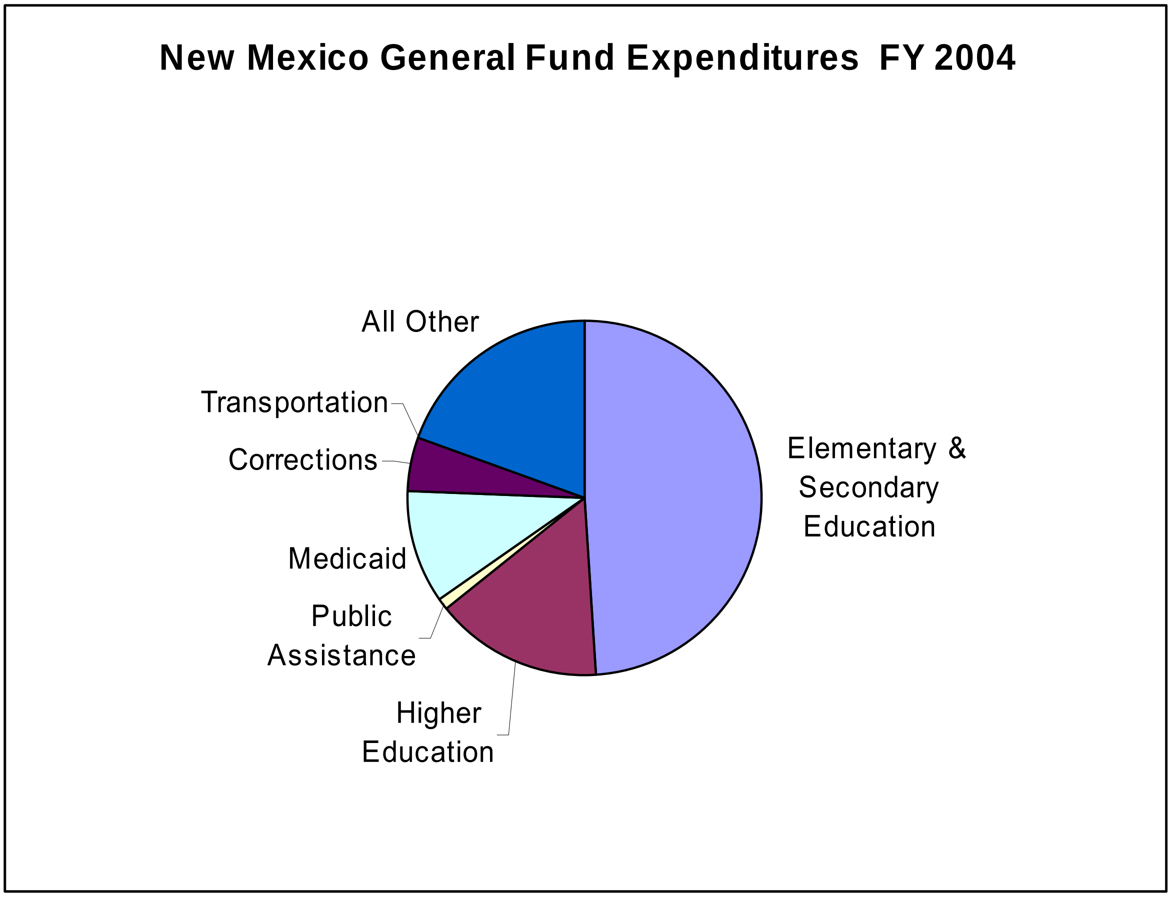

Figure 6-8. New Mexico General Fund Expenditures Fiscal Year 2004 (6-030).

Table 6-14. Revenue sources in the general fund Fiscal Year 2003 to Fiscal Year 2005 ($ in millions) (6-033).

State of New Mexico	Sales Tax	Personal Income Tax	Corporate Income Tax	Gaming	Other Taxes and Fees	Total
Fiscal Year 2003	1,375	923	102	39	1,496	3,935
Fiscal Year 2004	1,443	1,007	138	39	1,985	4,612
Fiscal Year 2005	1,557	1,086	243	46	2,056[a]	4,951

a. Estimated Fiscal Year 2005 from 2004 National Association of State Budget Officers Report.

Table 6-15. New Mexico tax growth rate summary (1998 to 2002) (6-036).

Annual Growth Rate	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)
Personal income tax	18	1	8	4	15
Gross receipts tax	5	3	2	10	4
Corporate income tax	5	-11	0	36	-29
Oil and gas taxes, rents and royalties	2	-24	48	84	-35
Investment income	7	7	-1	10	4
Total recurring revenue	7	-1	9	18	-3
Total excluding oil and gas revenue	8	2	5	8	5

Table 6-16. Equalization of 2005-2006 gross receipts tax revenues (6-041).

County	Net Receipts – Gross Receipts Tax ($)	Equalization Target ($)	Sept 2006 Equalization Distribution ($)
Chaves	1,325,154.50	1,890,206.93	565,052.43
Eddy	2,362,563.61	1,590,764.55	-
Lea	2,864,253.70	1,709,414.43	-
Roosevelt	300,171.42	554,849.12	254,677.70

6.8 Local Planning Requirements

The Roswell site is located in Chaves County, New Mexico. The Chaves County Zoning Ordinance, dated May 30, 1984, is applicable to the proposed site (6-042). There are no other applicable local codes or ordinances.

Chaves County is divided into two zoning areas. The Roswell site is situated in Area I which is zoned for agricultural and rural suburban use. Permitted uses include livestock grazing (farming and ranching), mineral exploration and production, wildlife habitat, and extensive recreation. Construction of single family dwellings requires a permit from the County. Other land uses require a special use permit or a change of zoning. There are no uses specifically prohibited in Chaves County Area I.

Four hundred and eighty acres of the Roswell site currently are zoned for industrial use as a hazardous waste disposal site pursuant to a special use permit (6-037). The proposed facility would require a modification of the present special use permit for GNEP uses and/or a certificate of zoning.

6.9 Social Services and Public Facilities

This subsection presents information on health facilities, emergency management and law enforcement, transportation and public libraries. Social services and public facilities are concentrated in the more populated cities within Chaves, Eddy, Lea, and Roosevelt Counties including Carlsbad, Hobbs, and Roswell (6-013, 6-014).

6.9.1 Present Social Services

There are numerous agencies devoted to providing the community with health and human resource services. Within the ROI there are home care providers, hospitals, medical laboratories, mental health services, substance abuse treatment facilities, foster care organizations, and agencies offering counseling and educational outreach services, as well as emergency service providers and law enforcement agencies (6-013, 6-014, 6-015, 6-035).

6.9.1.1 Health Facilities

The health services including medical centers, counseling services, childcare resources, crises care, and emergency services, are available within each of the four counties in the ROI. The major health facilities providing in patient care services and their locations are listed in Table 6-17.

6.9.1.2 Emergency Management and Law Enforcement

Each county within 50 miles of the Roswell site is served by municipal or volunteer fire departments with a total of 33 departments in the four county ROI. The fire departments listed in Table 6-18 are located within 50 miles of the Roswell site. In addition to federal law enforcement agencies, County and municipal law enforcement agencies in the ROI are summarized in Table 6-19.

Table 6-17. Summary of the major public health facilities within the ROI (6-018).

Health Facility	Licensed Beds	Location
Artesia General Hospital	34	Artesia
Eastern New Mexico Medical Center	145	Roswell
Nor-Lea General Hospital	25	Lovington
Lea Regional	194	Hobbs
Carlsbad Medical Center	97	Carlsbad
New Mexico Rehabilitation Center	41	Roswell

Table 6-18. Summary of fire departments within 50 miles of the Roswell site (6-015).

Fire Department	Location	County	Department Type	Number of Stations
Berrendo VFD	Roswell	Chaves	Volunteer	3
Chaves County Fire Department	Dexter	Chaves	Volunteer	2
City of Roswell Fire Department	Roswell	Chaves	Career	6
Dexter Fire & Rescue	Dexter	Chaves	Volunteer	2
East Grand Plains Volunteer Fire Department	Roswell	Chaves	Volunteer	1
Midway Fire & EMS	Dexter	Chaves	Volunteer	1
Artesia Fire Department	Artesia	Eddy	Mostly Career	2
Atoka Fire Department	Artesia	Eddy	Volunteer	2
Cottonwood Volunteer Fire Department	Artesia	Eddy	Volunteer	2
Riverside Volunteer Fire Department	Artesia	Eddy	Volunteer	1
Sun Country Volunteer Fire Department	Artesia	Eddy	Volunteer	2
Maljamar Fire Department	Maljamar	Lea	Volunteer	1
Lovington Fire Department	Lovington	Lea	Mostly Career	1
Tatum Volunteer Fire Department	Tatum	Lea	Volunteer	1
Dora Fire Department	Dora	Roosevelt	Volunteer	1
Elida Fire and Rescue	Elida	Roosevelt	Volunteer	1
Milnesand Fire & Ambulance	Milnesand	Roosevelt	Volunteer	2

Table 6-19. County and municipal law enforcement agencies in the ROI (6-035).

Law Enforcement Office	Location
Chaves County Sheriff's Office	Roswell
Hagerman Police Department	Hagerman
Lake Arthur Police Department	Hagerman
Roswell Police Department	Roswell
Eddy County Sheriff's Office	Carlsbad
Artesia Police Department	Artesia
Lea County Sheriff's Office	Lovington
Lovington Police Department	Lovington
Tatum Police Department	Tatum
Roosevelt County Sheriff's Office	Portales
New Mexico Military Institute Police	Roswell
New Mexico State Police District 3	Artesia

6.9.1.3 Transportation

Figure 6-9 shows the general transportation services, which include major roads, public airports, and railroads within 50 miles of the Roswell site, and is based on the 50-mile base map using data described in Section 1, Maps.

Four public-use airports within 50 miles of the Roswell site provide a variety of freight and passenger transportation capabilities. They include Roswell International Air Center Airport in Roswell (a primary commercial service), Artesia Municipal Airport in Artesia, Lea County-Zip Franklin Memorial in Lovington, and Tatum Airport in Tatum (6-016, 6-017).

Other public-use airports located outside the ROI but within the four counties of the study area include Cavern City Air Terminal in Carlsbad (non-primary commercial service), and Lea County Regional Airport in Hobbs. All airports within the ROI are projected to reach no more than 33 percent capacity by 2021 according to the 2005 State of New Mexico Infrastructure Report Card (6-020).

There is a Burlington Northern-Santa Fe Railway owned freight rail line that traverses the study area from Clovis to Carlsbad. Statewide, the rail transit system has earned a grade of B with advances in recent years attributable to a 50-50 match of federal funds for passenger rail infrastructure improvements (6-020).

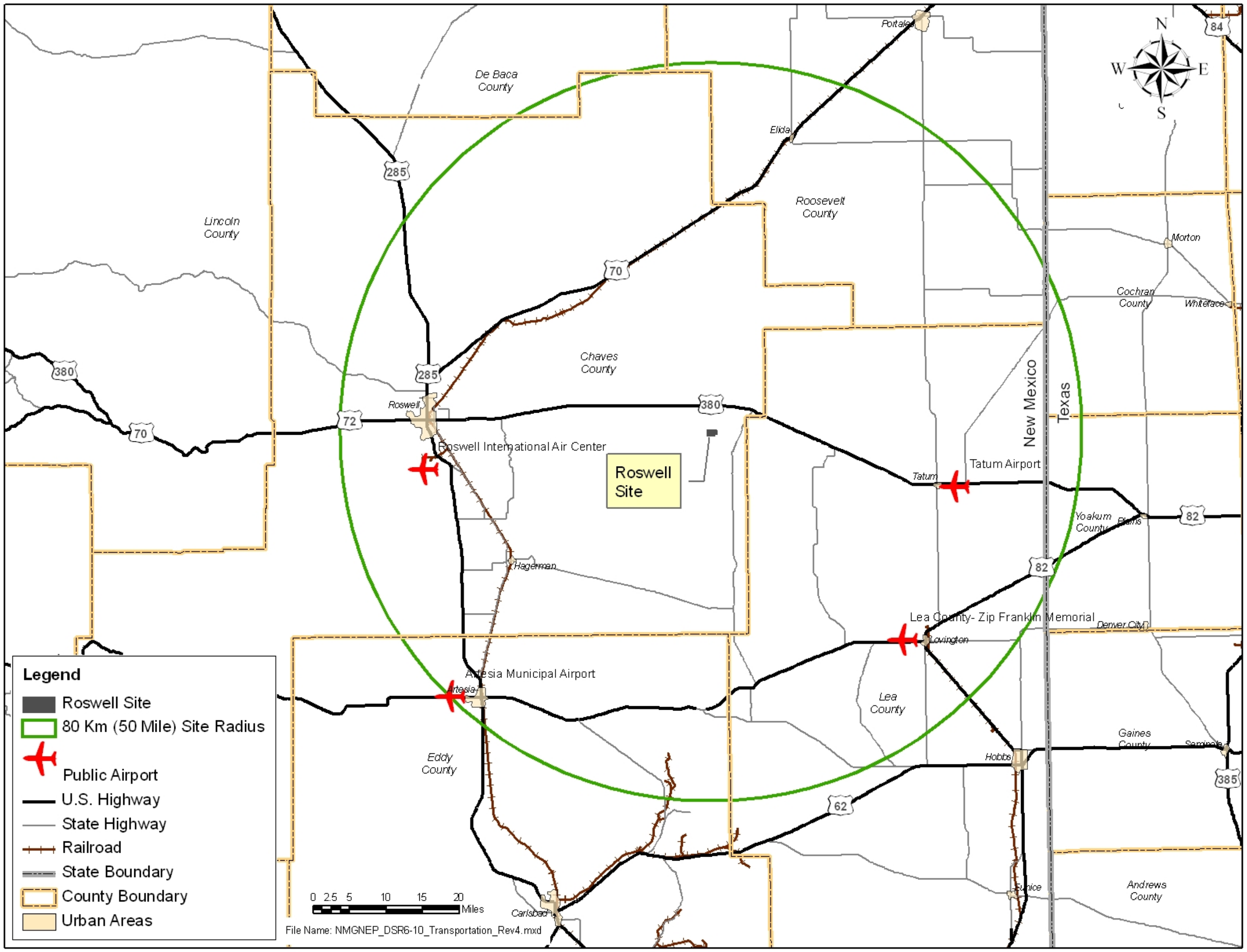

Figure 6-9. General transportation services within 50 miles of the Roswell site (6-043).

Public Transit Systems within the ROI are classified as rural areas by the New Mexico Department of Transportation (NMDOT). The various transit fleets within the state are reported to be “good mixtures of newer and older vehicles.” Vehicle replacement takes place with the “assistance of the Federal Transportation Administration’s program for rural areas (areas with populations under 50,000 residents)” (6-020). Transit systems throughout New Mexico have reported current funding levels that “appear to be adequate to maintain existing levels of service” (6-020).

In general, New Mexico’s highway system has gained an above average rating when compared with the rest of the nations’ roads. Table 6-20 shows how the percentage of New Mexico roads rated “good” or “fair” changed from 2001 to 2004. A large number of the roads within the study area are non-interstate, non-National Highway System roads.

Table 6-20. Percentage of New Mexico roads rated “Good” or “Fair” from 2001 to 2004 (6-020).

	2001 (%)	2002 (%)	2003 (%)	2004 (%)
Interstate	93.7	93.7	98.3	95.0
Non-Interstate/National Highway System	90.3	90.3	96.5	95.4
Non-Interstate/Non-National Highway System	65.7	72.0	62.4	68.4

6.9.1.4 Public Libraries

There are six public library facilities within the ROI with a combined total circulation of 422,655 in 2004. Information regarding these facilities is listed in Table 6-21.

Table 6-21. Summary of public libraries in the ROI (6-001).

Public Libraries (2004)	Tatum	Elida	Lovington	Dexter	Roswell	Artesia
Book and Serial Volumes	9,565	3,000	36,212	4,477	145,870	52,647
Subscriptions	21	N/A	41	N/A	185	152
Video Materials	258	N/A	1,219	N/A	1,692	943
Audio Materials	179	N/A	1,663	N/A	2,966	1,100
Total Circulation	2,985	645	35,919	983	335,715	46,408
Children’s Materials Circulation	569	N/A	15,725	184	134,031	23,913

6.10 Population Density

Figure 6-10 shows the population density in each census block group in the region based on the 2000 Census. At a radial distance up to 20 miles from the Roswell site, the population density is estimated to be very low at less than 0.1 people per square mile (6-006, 6-011).

At a radial distance up to 50 miles of the Roswell site, the great majority of the area has a population density of less than 10 people per square mile. In some areas of Roswell, Artesia, and Lovington, however, the population density is greater than 1,000 people per square mile (6-006). Based on the 2000 Census the average population density within 50 miles from the Roswell site is estimated to be less than 12 people per square mile (6-011).

6.11 Distance from the Roswell Site to Nearest Population Centers

Figure 6-11 shows the location of population centers in the region that are over 20,000, 50,000 and 100,000 (6-006). The closest population center over 20,000 is Roswell, New Mexico, which is approximately 40 miles west of the Roswell site. Other cities with a population over 20,000 within 100 miles of the Roswell site include: Carlsbad, Hobbs, and Clovis, New Mexico. The closest population center over 50,000 and 100,000 is Lubbock, Texas, which is approximately 115 miles east of the Roswell site.

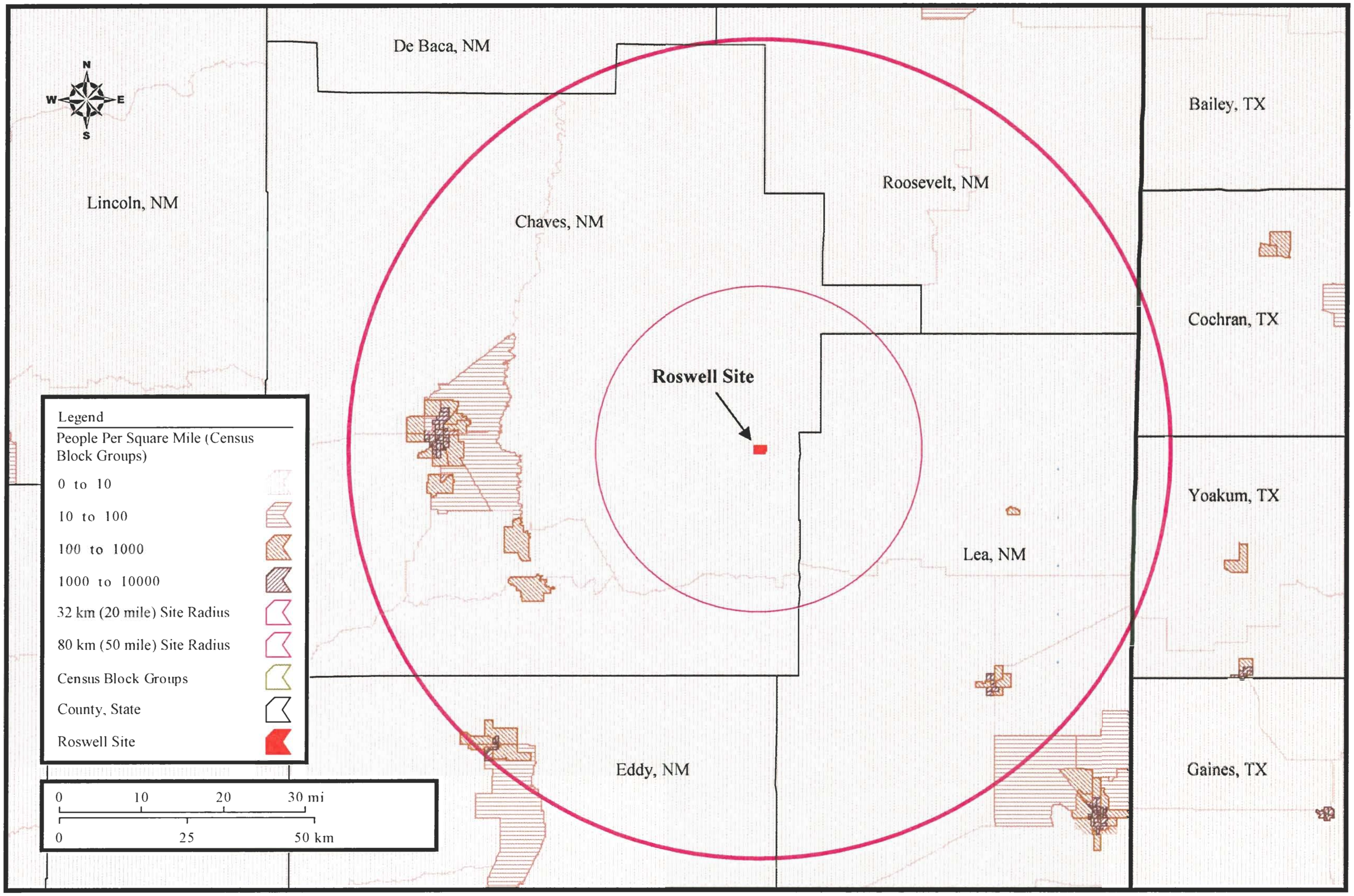

Figure 6-10. Population density at a radial distance of 50 miles from the Roswell site (6-006).

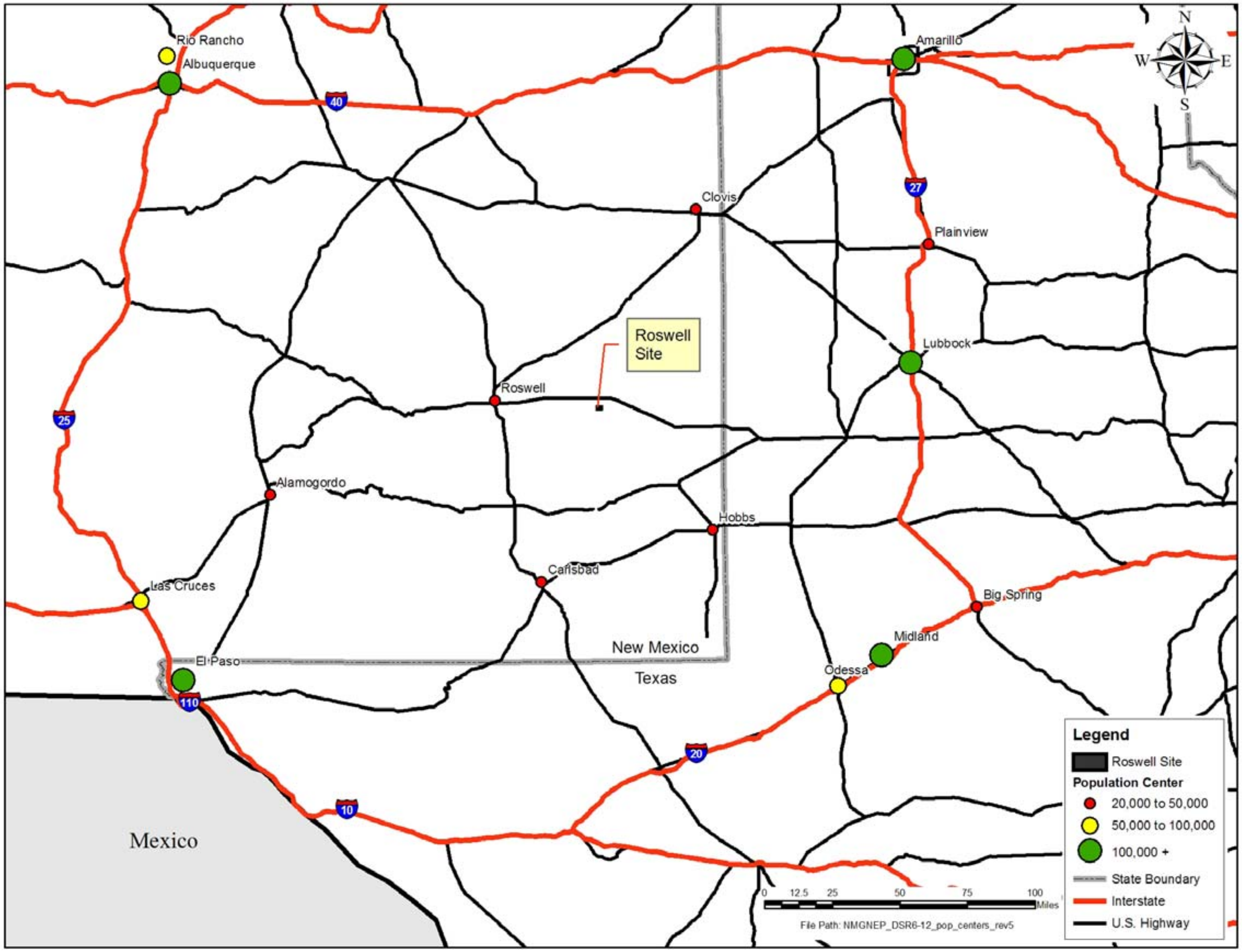

Figure 6-11. Distance from the Roswell site to nearest population centers (6-045).

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CONTENTS

FIGURES

TABLES

7. HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Potential direct impacts from construction and operation of a GNEP facility at the Roswell site could include the destruction of archaeological sites or the introduction of auditory or visual elements that may compromise the integrity of existing archaeological sites. Indirect impacts to archaeological sites may include increased visitation that may lead to looting and increased vehicular traffic that may result in the destruction of sites. In order to mitigate the impact of proposed facilities this initial data compilation effort included a field survey to identify any historical or archaeological sites within the Roswell site area. The sections presented below describe historical, archaeological, and cultural resources that occur within or near the Roswell site that may potentially be disturbed by construction and operation of the GNEP facilities.

7.1 Overview and Summary

A review of the most current information based on readily available and existing files and field surveys of the Roswell site indicates:

- There are no off-site historical, archaeological, or cultural resources that would be affected by the proposed GNEP facilities.
- On-site historical, archaeological, and cultural properties on the Roswell site can be isolated to prevent the potential to be disturbed by construction and operation of the GNEP facilities.
- No previously recorded cultural resources exist within the Roswell site boundaries.
- Ten newly recorded sites, 12 previously recorded sites, and 57 isolated occurrences of historical and archaeological properties were identified adjacent to or within the site boundaries during file reviews and site surveys.
- The 12 previously recorded sites are adjacent to but not located within the Roswell site boundaries.
- Of the 10 newly recorded sites, three of the sites are eligible for inclusion on the National Register of Historic Places and seven of the sites are potentially eligible for inclusion on the National Register of Historic Places.

7.2 Background

This section briefly describes and summarizes the prehistoric, ethnohistoric, and historic cultural contexts of the area. Each broad period is discussed separately below to provide a proper context for evaluation of field survey results. The cultural history of southeast New Mexico was first summarized for the Jornada branch of the Mogollon in 1948 (7-030), for the Middle Pecos Valley in 1967 (7-002), and for the Sierra Blanca region, just west of the Roswell site, in 1984 (7-010). The first attempt to synthesize the entire southeastern portion of New Mexico was undertaken in 1989 (7-003). Recently, this synthesis has been updated with a regional research design and cultural resource management strategy for southeastern New Mexico (7-026).

7.2.1 Prehistory

The Paleoindian Period is usually dated from 10,000 to 5,500 B.C. although earlier sites periodically contend for antiquity. The Paleoindian record on the Mescalero Sands, a band of wind-deposited sand and sand dunes of variable width that extends north-south along the western edge of the Mescalero Ridge escarpment (7-008), is meager. Most investigators concede that the Paleoindian period was one of small groups of gatherers and hunters exploiting the fauna of the region. Investigators often classify the Paleoindian Period into three complexes: Clovis (10,000 to 8,500 B.C.), Folsom (9,000 to 8,000 B.C.), and Plano (8,000 to 5,500 B.C.).

The Clovis type site of Blackwater Draw (7-025) lies approximately 80 miles north of the Roswell site and near the modern town of Clovis, New Mexico. Clovis and other Paleoindian Period remains were reported from the Roswell area in 1979 (7-017). During the later Paleoindian Period, the economic focus probably shifted from extinct Pleistocene megafauna to bison.

The Archaic Period (5,500 B.C. to A.D. 750) saw a shift in economic strategies towards a more generalized adaptation to the floral and faunal resources of the area. These sites precede the introduction of ceramic technology but may contain shallow pit dwellings. Given the geomorphology of the Roswell site and the surrounding countryside, the recognition of Archaic sites is difficult at best. Elsewhere in the Southwest, agriculture made its appearance during this time period along with water management (7-020). Most of the sites recognized or considered to be Archaic postdate A.D. 1 (7-003) and show an increased orientation to limited resources. It is suggested that middle to late Archaic sites in southeastern New Mexico were commonly open-air camps clustered near riparian resources (7-009, 7-027, 7-028). Upland foraging appears to have developed over time but agricultural pursuits were late to make an impact in the area.

The Ceramic Period (A.D. 750 to 1500) is one of the best represented periods in the Roswell site and many of the sites listed as unknown (seemingly Archaic) may well have ceramics present in buried contexts. In southeastern New Mexico, the Ceramic Period has been divided into a number of phases (7-026). Early archaeological investigations (7-002, 7-030, 7-010) focused on this period. The Ceramic Period cultural manifestation in this part of southeastern New Mexico is considered to be related to the Jornada Mogollon and investigators have developed a sequence for the region (7-018, 7-031). This sequence includes the following phases (7-031):

The Querecho Phase is dated from A.D. 950 to A.D. 1150 and is characterized by the appearance of ceramics and corner-notched arrow points. No structural sites have been recognized for the Querecho Phase. Ceramic types found in sites dating to this period are principally related to Jornada Brown Wares. Sites of this time period are common in the mesquite and shinnery oak covered sand dunes and most likely represent foraging trips.

The following Maljamar Phase dates to between A.D. 1150 and A.D. 1300. Sites appear to represent more sedentary lifestyles but continue to include foraging camps. Some sites have been found that have 20 to 30 structures. The Jornada Brown Wares that appear in the preceding phase continue into this phase and are joined by corrugated wares and Chupadero black-on-white as the main painted type (see Figure 7-1). During this phase, corner-notched projectile point styles are succeeded by side-notched projectile points. There may have been some disruption in settlement and/or abandonment of the area at the end of the phase.

Figure 7-1. Fragment of the Chupadero black-on-white ceramic type.

The Ochoa Phase, dating between A.D. 1350 and A.D. 1500, saw the development of village sites. Ochoa Indented and Chupadero black-on-white are the main ceramic types and projectile points assume triangular shapes with notched or indented bases during this phase.

The Prehistoric and Protohistoric Periods date from about A.D. 1350/1500 to A.D. 1700. The region appears to have been abandoned by farmers and foragers in favor of a more mobile bison hunting lifestyle. During the Protohistoric, the region was probably utilized by Jumano nomads. This group consisted of bison hunters that had developed relationships with the pueblos on the lower Río Grande (7-033). By the mid-1500s, the Apache made their way into the historical record for using the area. They remain there today, west of the Roswell site in the Sierra Blanca region.

7.2.2 History

The Historic and Recent Periods in southeastern New Mexico date to between A.D. 1700 and the present. There is little record of Native American use of the area and the Spanish incursion into this area is not well known although Coronado passed north of the area on his exploratory journey that led him from Hawikku in western New Mexico (7-019) to the Plains and west Texas (7-013). Difficulties have been noted in identifying use of the area by hunter and gatherers during this time period due to the scarcity of material culture that would have been deposited (7-003). Mescalero Apache and Comanche use of the area continued into this time period and the Spanish began to colonize and develop trade routes. Euro-American use of the area increased after the Mexican War in 1848 and military posts were established (7-003).

Pressure from cattle ranchers pushed Native Americans out of the area. These cattle ranchers played a key role in opening up and developing the region to Euro-American settlement. The 1862 Homestead Act was also important in bringing people into the area. Under the Homestead Act, settlers were encouraged to develop homesteads that often included a dugout, a well, a windmill and water tank, and an outhouse. Although many of these homesteads were built in southeastern New Mexico, the settlers succeeded only with great difficulty. The drilling of water wells began in the late 1800s and offered greater success in making a living.

By the first decade of the 1900s, homesteading had surpassed cattle ranching as the most significant economic strategy in the area and southeastern New Mexico was the recipient of a growth spurt. The historic period sites located within the Roswell site date to this time period. During the rest of the twentieth century the history of settlement in the area saw boom periods with the development of the energy industry and the establishment of military bases. Cattle ranching remains a primary economic focus in the area today.

7.3 Methods

An intensive pedestrian inventory with 100 percent pedestrian survey coverage with a maximum transect interval of 50 feet was conducted. A crew of six personnel conducted the survey from February 26 to March 2, 2007. The transects ran north to south and were walked by a crew of six individuals. The survey consisted of the visual examination and logging of archaeological artifacts or features visible at ground surface. Excavation of archaeological sites was not performed. The pedestrian transects were recorded as points between features using a Trimble GeoXT Global Positioning System (GPS) unit with TerraSync and Pathfinder Office software. The Roswell site boundary map was taken into the field as a layer on the TerraSync software along with the pertinent digital orthophotographs.

7.3.1 Bureau of Land Management Guidance

The following BLM definitions (7-014) that identify cultural resources on private lands were used to record the archaeological sites:

- **Site** – A site is a physical location of past human activities or events. Cultural resource sites are extremely variable in size and range from the location of a single cultural resource object to a cluster of cultural resource structures with associated objects and features. A site may consist of secondarily deposited cultural resource remains (7-014).

- **Isolated Manifestation** – An isolated manifestation or isolated occurrence generally contains less than 10 artifacts or a single undatable feature. It will frequently be found to be redeposited material that lacks significant locational context, and will not be related to other nearby isolated manifestations or sites (7-014).

The term "site," as used in this section, describes the surface artifact scatter only, rather than actual archaeological site boundaries which usually cannot be determined accurately without subsurface testing. The term "Roswell site" will be used to distinguish discussion of the Roswell site location from archaeological sites.

7.3.2 Archaeological Site Mapping

Archaeological sites identified during the survey were mapped and fully recorded using a Trimble GeoXT GPS unit. Permanent site datums were established for each site with rebar or spikes and a metal plate tag containing the site field number, project number, the name of the archeological survey team who recorded the site, and the date that the site was recorded. Sites were described and recorded on Museum of New Mexico, Laboratory of Anthropology Site Record forms. Calculations for site areas were derived from measurements taken from site maps. Sites were documented with digital photos. For small sites (sites that contain 100 or less artifacts), field archaeologists recorded all artifacts (see Figure 7-2). Isolated occurrences were recorded on Isolated Artifact forms. The range of variation and quality of surface artifacts was documented on standard surface tabulation forms. A New Mexico Cultural Resource Information System (NMCRIS) Investigation Abstract form was also filled out.

Each site or isolated occurrence was thoroughly recorded. The artifacts and features observed on a site were noted. The geographic location, physical characteristics, archaeological, and historic attributes were described in detail on a Laboratory of Anthropology site form. Each site area was photographed. Diagnostic artifacts and site features were mapped along with site boundaries. Ground visibility ranged from 50 percent in areas covered with sand dunes, mesquite, and/or creosote to 100 percent near areas away from eolian activities. Average ground visibility was approximately 75 to 80 percent.

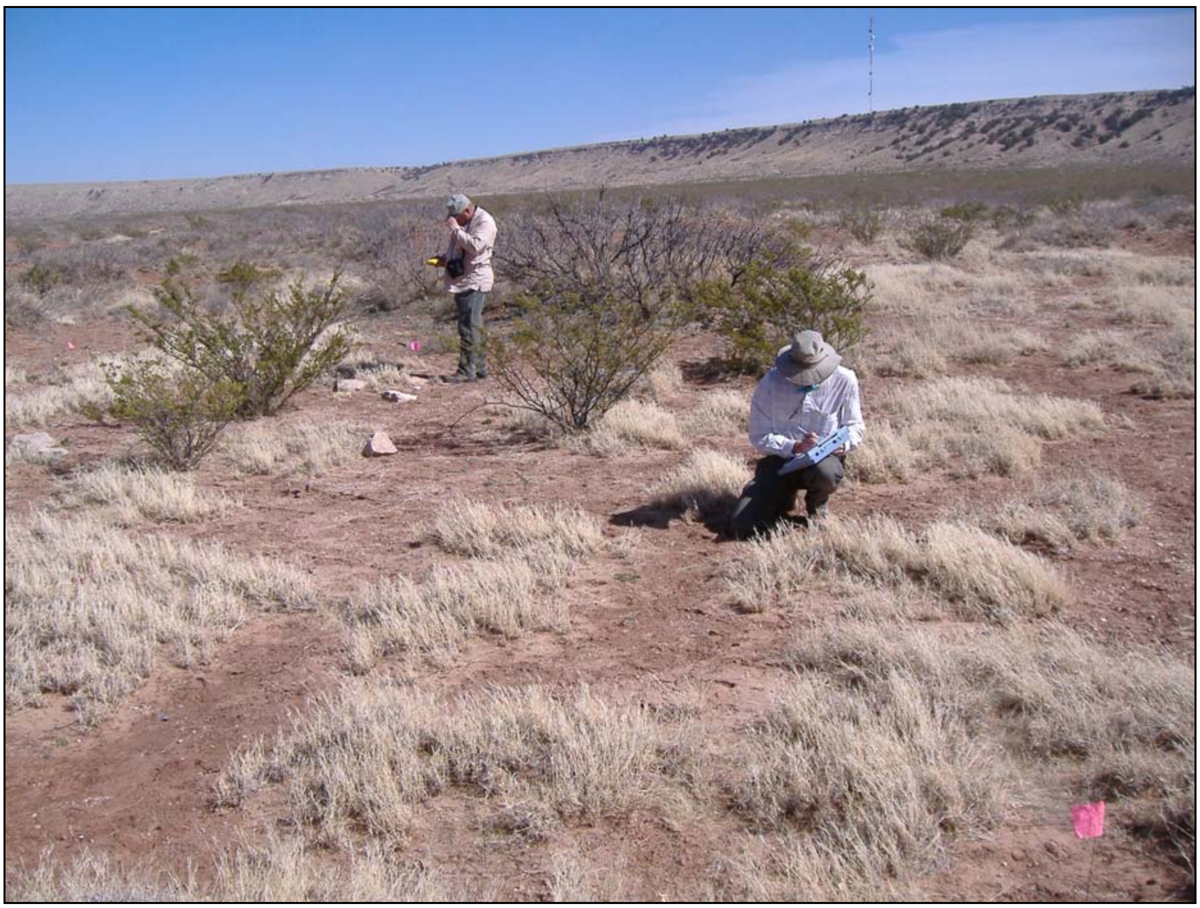

Figure 7-2. Crew recording a site at the Roswell site.

7.3.3 Traditional Cultural Properties Research

The traditional cultural properties assessment of the Roswell site was conducted to identify cultural resources eligible for nomination to the NRHP (including those identified as traditional cultural properties), properties that may warrant consideration under the American Indian Religious Freedom Act (AIRFA), any modern or historic burials that may be impacted by the proposed undertaking, in-use properties, and any other cultural resource that may be of significance to local residents and that might be adversely impacted as a result of the undertaking.

The following definition of traditional cultural property, taken from the National Park Service National Register Bulletin 38, was used in this report:

- **Traditional Cultural Property** – A property that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that 1) are rooted in that community's history, and 2) are important in maintaining the continuing cultural identity of the community (7-032).

Information on traditional cultural properties was sought through consultation letters sent out to tribes who claim affinity to traditional cultural properties located in Chaves County. These tribes include the Apache Tribe of Oklahoma, the Comanche Indian Tribe, the Kiowa Tribe, the Mescalero Apache Tribe, and Ysleta del Sur Pueblo.

7.3.4 Evaluation of Significance

All cultural resources described above must be evaluated for significance and/or consideration under the following federal legislation and regulations: the NHPA of 1966, as amended (36 CFR 800); the NRHP (36 CFR 60); the ARPA of 1979 (43 CFR 7); and the AIRFA of 1978 (P.L. 95-341). This legislation provides for the protection of historic and prehistoric sites and those resources that are significant to the traditional beliefs of a community. Additionally, any cultural resources that might be impacted by this project must also be evaluated under the New Mexico Cultural Properties Act and New Mexico Prehistoric and Historic Sites Preservation Act.

As stated in 36 CFR 60.4:

> *The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:*
>
> *(A) That are associated with events that have made a significant contribution to the broad pattern of our history; or*
>
> *(B) That are associated with lives of persons significant in our past; or*
>
> *(C) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*
>
> *(D) That have yielded, or may be likely to yield, information important in prehistory or history.*

Criteria (A), (B), and (D) are the criteria applicable to most historic and prehistoric sites encountered during field inventories, including all of the sites recorded during the current project.

The National Park Service, National Register Bulletin 38, "Guidelines for Evaluating and Documenting Traditional Cultural Properties," provides additional guidance on how properties may be eligible for inclusion in the NRHP:

> *...The word [culture] is understood to mean the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community...One kind of cultural significance a property may possess...is traditional cultural significance. "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is a significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices* (7-032).

The ARPA provides for the protection of archaeological resources located on public lands and Indian lands of the United States. Under 43 CFR Part 7, an "archaeological resource" is defined as "any material remains of past human life or activities which are of archaeological interest... [and are] at least 100 years of age."

The AIRFA directs the federal executive branch to "protect and preserve Native American religious cultural rights and practices" (Sec. 2., 92 STAT. 470). Specifically, AIRFA (P.L. 95-341, 92 STAT. 469) states, "it shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom of worship through ceremonials and traditional rites."

The New Mexico Cultural Properties Act "provides for the preservation, protection and enhancement of structures, sites, and objects of historical significance..." while the New Mexico Prehistoric and Historic Sites Preservation Act states that any state-funded project must employ "all possible planning to preserve and protect and to minimize harm to... prehistoric and historic site[s]" that may result from "… the use of any portion of or any land from a significant... site unless there is no feasible and prudent alternative to such use."

7.4 Results

A file search of available cultural resource databases indicated no previously recorded cultural resource sites within the Roswell site. Ten newly recorded sites, 12 previously recorded sites, and 57 isolated occurrences were recorded within or near the Roswell site as a result of the field surveys and literature search. These are described below.

7.4.1 File Search Results

Prior to fieldwork, a file and literature search was performed for all sections within the Roswell site with the NMCRIS. A search of the NMCRIS with the Archeological Records Management Sections (ARMS) of the Historic Preservation Division, Department of Cultural Affairs was conducted on August 14, 2006 and again on February 12, 2007 (7-001). This record search noted no (N=0) previously recorded cultural resources within the Roswell site. One previous cultural resource assessment was carried out near the Roswell site. This assessment was performed in 1992 and included 397.7 acres of linear transects (7-004).

7.4.2 Newly Recorded Sites

This section presents the results of the field survey inventory. Ten sites (sites LA 155719 through LA 155728) were recorded during the current survey. Laboratory of Anthropology Site Record forms were completed for all newly recorded sites. Three of the sites are eligible and seven of the sites are potentially eligible for inclusion on the NRHP. The 10 newly recorded sites that were located during the course of this project are described in Table 7-1.

Table 7-1. Newly recorded sites at the Roswell site.

Field No.	Site No.	Type of Property	Artifacts/Features	NRHP Eligibility	NRHP Criteria[a]
FN 1	LA 155719	Lithic scatter	Flakes	Potentially eligible	D
FN 2	LA 155720	Lithic scatter	Flakes, groundstone fragment	Potentially eligible	D
FN 3	LA 155721	Lithic scatter	Flakes	Potentially eligible	D
FN 4	LA 155722	Lithic scatter	Flakes, sherds, projectile point base, burned rock	Potentially eligible	D
FN 5	LA 155723	Lithic scatter	Flakes, sherds	Potentially eligible	D
FN 6	LA 155724	Lithic scatter	Flakes, sherds	Potentially eligible	D
FN 7	LA 155725	Lithic scatter near thermal features	Flakes, sherds	Eligible	D
FN 8	LA 155726	Lithic scatter, residence	Lithic artifacts, glass cartridge, rock wall	Eligible	D
FN 9	LA 155727	Lithic scatter	Flakes	Potentially eligible	D
FN 10	LA 155728	Lithic scatter, thermal feature, residence	Flakes, sherds, hearth, rock alignment, dump, rock pile	Eligible	D

a. See Section 7.3.4

7.4.3 Site Descriptions

Site LA 155719
Temporary Number: FN 1
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500)
Landform: Sand dune blowout
Maximum Size: 115 feet × 33 feet

Site Description: This site is a diffuse lithic scatter composed of 17 flakes in a sand dune blowout. Additional artifacts and/or features may lie unexposed within the sand dune area that surrounds the site. No other cultural material was evident. The flakes at the site were mapped and counted. No time diagnostic material was encountered.

The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface, but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C.

Mesquite, shinnery oak, and various grasses cover the sand dunes and provide stability but the cultural deposits have probably already been removed from their in situ positions.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. All the artifacts noted at the site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155720
Temporary Number: FN 2
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500)
Landform: Sand dune blowout
Maximum Size: 154 feet × 82 feet

Site Description: This site is a diffuse lithic scatter composed of 17 flakes and one groundstone fragment in a sand dune blowout. Additional artifacts and/or features may lie unexposed within the sand dune area that surrounds the site. No other cultural material was evident. The flakes at the site were mapped and counted. No time diagnostic material was encountered.

The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C.

Mesquite, shinnery oak, and various grasses cover the sand dunes and provide stability but the cultural deposits have probably already been removed from their in situ positions.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. All the artifacts noted at the site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155721
Temporary Number: FN 3
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500)
Landform: Sand dune blowout
Maximum Size: 108 feet × 59 feet

Site Description: This site is another diffuse lithic scatter composed of 22 flakes in a sand dune blowout. Additional artifacts and/or features may lie unexposed within the sand dune area that surrounds the site. No other cultural material was evident. The flakes at the site were mapped and counted. No time diagnostic material was encountered.

The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The proximity of this site to site LA 155720 probably indicates that prehistoric cultural manifestations are ubiquitous throughout the sand dune environment and that these manifestations (sites composed of lithic flakes, groundstone, sherds, etc.) are apparent in blowout areas.

Mesquite, shinnery oak, and various grasses cover the sand dunes and provide stability but the cultural deposits have probably already been removed from their in situ positions.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. All the artifacts noted at the site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155722
Temporary Number: FN 4
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Jornada Mogollon (A.D. 950 to A.D. 1500)
Landform: Low rise covered with sand dunes and blowouts
Maximum Size: 738 feet × 230 feet

Site Description: This site is a large artifact scatter that contains two areas with artifacts concentrated on a blowout surface. Burned rock (probably from a hearth, or burned rock midden, or other thermal feature) is also evident on the surface but has been reworked by eolian deflation and their former outlines are not definable. One-hundred six lithic flakes were encountered mainly within the two artifact concentrations. In addition to these flakes, 83 brown ware sherds that can be subsumed into the Jornada Brown Ware series were also registered. A base of a single corner-notched projectile point was found near the top of the low rise (knoll). Additional artifacts and/or features may lie unexposed within the sand dune area that surrounds the site. Indeed, it was difficult to discern where this site stopped and where another site began. A number of isolated occurrences could have been grouped into this or other nearby sites.

The artifacts lie within sand dune deposits and on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The presence of Jornada Brown Ware and a corner-notched projectile point (and the absence of corrugated ware or such types as Chupadero black-on-white) indicates that this site is early in the Ceramic Period and may belong to the Querecho Phase (A.D. 950 to 1150), diagnostic of which is the initial occurrence of ceramics and corner-notched arrow points (7-031).

Mesquite, shinnery oak, and various grasses cover the sand dunes and provide some stability but many of the cultural deposits have probably already been removed from their in situ positions.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. Given the large size of this site and the presence of intact sand dunes, such may be the case. The artifact concentrations and the projectile point at this site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155723
Temporary Number: FN 5
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (A.D. 950 to A.D. 1500)
Landform: Sand dune blowout
Maximum Size: 121 feet × 66 feet

Site Description: This site is a lithic scatter composed of 48 lithic flakes and five Jornada Brown Ware sherds in a sand dune blowout. Additional artifacts and/or features may lie unexposed within the sand dune area that surrounds the site. No other cultural material was evident. The flakes at the site were mapped and counted. No time diagnostic material was encountered. This site is close to site LA 155723 and may, in fact, be part of a larger pattern of land use focused on the sand dune environment and its floral resources including shin oak and mesquite.

The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The presence of Jornada Brown Ware sherds further restricts the occupational span of this site to after A.D. 950.

Mesquite, shinnery oak, and various grasses cover the sand dunes and provide stability but the cultural deposits have probably already been removed from their in situ positions.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. All the artifacts noted at the site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155724
Temporary Number: FN 6
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (A.D. 950 to A.D. 1500)
Landform: Sand dune blowout
Maximum Size: 46 feet × 49 feet

Site Description: This small site is made up of 22 lithic flakes and three Jornada Brown Ware sherds in an area just east of the main sand dune field. No other cultural material was evident. The flakes at the site were mapped and counted. No time diagnostic material was encountered.

The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, and 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The presence of the Jornada Brown Ware sherds indicates that this site was used after A.D. 950. The close proximity of this site (as defined during the fieldwork activities) to site LA 155725 (below) implies that both are part of a larger use of the prehistoric landscape for the gathering of such resources as shin oak, mesquite, etc.

Creosote, mesquite, shinnery oak, and various grasses cover the ground and provide stability but the cultural deposits have probably already been removed from their in situ positions. This location is somewhat removed from the main sand dune field but eolian action has inflated and deflated sand deposits here also.

Eligibility Recommendations: Site integrity is poor. Eolian processes have affected the integrity of the site. It is possible that additional material lies under the sand in intact cultural deposits or in other buried depositional environments. All the artifacts noted at the site have been recorded and mapped thus exhausting their informational potential. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within buried deposits, this site is only potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155725
Temporary Number: FN 7
Type: Prehistoric Artifact Scatter (non-structural) with Features
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500)
Landform: Flat plain surrounded by coppice dunes
Maximum Size: 427 feet × 131 feet

Site Description: This site is a large lithic scatter with three thermal features. Most of the artifacts at the site are restricted to the northern end near Features 1 and 2. These artifacts include 130 lithic flakes and 115 ceramic sherds. The ceramic sherds consist of 108 plain brown ware (Jornada Brown Ware) and seven Chupadero black-on-white sherds. Feature 1 is an area of fire-cracked rock with ash around which most of the artifacts are strewn. Feature 2 is a discard pile of fire-cracked rock just south of Feature 1. Feature 3 lies approximately 295 feet to the southwest of Feature 2 and is a concentration of fire-cracked rock, ash, and artifacts. Feature 3 could as easily been considered part of site LA 155724. The artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The presence of Chupadero black-on-white sherds indicates that the site was used during the Maljamar Phase (A.D. 1150 to A.D. 1300) (7-031).

Creosote, mesquite, shinnery oak, and various grasses cover the terrain and the sand deposits and provide stability. The overall impression of this site is that, although it is open and the artifacts exposed, its condition is good and it reflects patterns of use in the distribution of the artifacts and features.

Eligibility Recommendations: Site integrity is good although the deposits at this site have been deflated by the wind. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within the features present and possible buried deposits, this site is eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is eligible for listing to the NRHP. Because of its eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155726
Temporary Number: FN 8
Type: Prehistoric Artifact Scatter (non-structural) and Single Residence (structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500) and historic (A.D. 1880 to A.D. 1920)
Landform: Flat plain surrounded by coppice dunes
Maximum Size: 115 feet × 33 feet

Site Description: This site consists of two components. The first component is defined by the presence of a diffuse lithic scatter without time diagnostic artifacts. These artifacts cover the site and are indicative of a prehistoric use of the site. Sixty-five lithic artifacts were observed. No prehistoric ceramics were identified.

The second component pertains to the historic period between A.D. 1880 and A.D. 1920 on the basis of time diagnostic historic artifacts such as purple glass and a .30 caliber Winchester Repeating Arms cartridge. Two historic artifact concentrations were noted and mapped for this site. The first concentration lies on the eastern edge of the site near a rock wall alignment (Feature 1) that appears to represent a habitation of some sort. Feature 1 is L-shaped with a northern dimension of approximately 16 feet and an eastern width of approximately 10 feet. The wall alignment is composed of 16 naturally occurring limestone rocks. The second historic artifact concentration lies on the western edge of the site.

The prehistoric artifacts lie on reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. The historic component has clearly been placed upon this exhumed soil during a period from A.D. 1880 and A.D. 1920 and probably represents homesteading/ranching activities that might also be related to Causey Ranch (site LA 43747).

Creosote, mesquite, shinnery oak, and various grasses cover the coppice sand dunes that flank the site. This vegetation provides some stability but the prehistoric cultural deposits have probably already been removed from their in situ positions. The historic component remains intact and in good shape.

Eligibility Recommendations: Site integrity is good to excellent. Eolian processes have deflated much of the sand around the site but the historic component has not been affected by these processes. The historic component contains information on the Anglo settlement of the region. Therefore, the site is eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is eligible for listing to the NRHP. Because of its eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155727
Temporary Number: FN 9
Type: Prehistoric Artifact Scatter (non-structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500)
Landform: Low rise with coppice dunes
Maximum Size: 49 feet × 29 feet

Site Description: This site is a prehistoric lithic scatter consisting of 19 flakes in a small area. Within this area were also found fire-cracked rock that suggests food processing was carried out at the site. No formal features were noted although such may lie buried within the sand dune deposits.

Creosote, mesquite, shinnery oak, and various grasses cover the low rise and provide some stability. No time diagnostic artifacts were observed and the fire-cracked rock concentration appears to have been affected by erosion. This site is typical of sites in the region and in the Roswell site in that it probably is a component of a larger cultural landscape of foraging for such resources as mesquite and shin oak.

Eligibility Recommendations: Site integrity is poor and the deposits at this site have been deflated by the wind. Because of the possibility that this site (and others within the Mescalero Sands) retains some information potential within the features present and possible buried deposits, this site is potentially eligible for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and therefore not eligible under Criterion C.

Management Recommendations: The site is potentially eligible for listing to the NRHP. Because of its potential eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

Site LA 155728
Temporary Number: FN 10
Type: Prehistoric Artifact Scatter (non-structural) and Single Residence (structural)
Cultural Period: Unknown prehistoric (5,000 B.C. to A.D. 1500) and historic (A.D. 1880 to A.D. 1920)
Landform: Prominent low rise surrounded by coppice dunes
Maximum Size: 1,181 feet × 787 feet

Site Description: This is a large site that covers most of a prominent but low rise in the northeast portion of the Roswell site. The site is composed of two components: prehistoric and historic. The prehistoric component is a diffuse but extensive scatter of lithic flakes and ceramic sherds. The low rise is covered with sand dune deposits and artifacts were noted lying on the surface in almost every blowout visited during the fieldwork. On the northern edge of the site, one prehistoric feature was recorded. This feature (Feature 1) is a thermal feature (hearth) consisting of scattered fire-cracked rock and ash. Artifacts were common in and around the feature. The widespread scatter of lithic flakes over the site numbers in the 100s. Ceramic (Jornada Brown Ware) sherds were also noted.

The historic component is confined to the southern portion of the site and the south side of the low rise. This historic component is the remains of a single residence with historic artifacts present that date the site to between A.D. 1907 and A.D. 1925. The historic component is also made up of four features (Features 2 through 5). Feature 2 is in the form of two joined rectangles made up of rock alignments that measure 37.7 feet (East to West) and 13 feet (North to South). This feature would appear to have been a residential structure. Feature 3 is a smaller rock alignment also associated with historic artifacts. This alignment is approximately 8.2 feet long. Feature 4 is an historic dump that lies 417 feet southwest of Feature 2. The dump contains metal artifacts. Feature 5 is a small rock concentration (a pile of rocks) that lies near the southern edge of the site. Not included in the site boundary is a stock tank that is currently in use. This stock tank may have originally been dug during the early part of the twentieth century and thus relate to the historic use of this area, a use that also included the Causey Ranch.

The prehistoric artifacts lie above the reddish sand that has been exhumed by eolian deflation. It is not clear as to whether this reddish sand was the original occupational surface but studies (7-008, 7-021, 7-022, 7-023) suggest that most cultural material has been deflated and redeposited within the sand dune system. Since the artifacts lie above the reddish soil, they seemingly post-date 5,000 B.C. No other temporal assignment is possible given our present knowledge. The historic artifacts lie on soils that appear to have been relatively stable during the last 100 years.

Creosote, mesquite, shinnery oak, and various grasses cover the coppice sand dunes that lie atop the low rise and provide stability.

Eligibility Recommendations: Site integrity is good to excellent. Eolian processes have affected the distribution of the prehistoric artifacts at the site. It is possible that additional material lies under the sand dunes in intact cultural deposits or in other buried depositional environments. The historic component is in good shape, retains its integrity, and contributes to the site's eligibility for listing to the NRHP under Criterion D. This site is not associated with events that made a contribution to the broad patterns of local or regional history and is therefore not eligible under Criterion A. The site is not associated with persons of local or national significance and is not eligible under Criterion B. The site is not unique in design or construction and is therefore not eligible under Criterion C.

Management Recommendations: The site is eligible for listing to the NRHP. Because of its eligibility, the site should be avoided. Avoidance can be accomplished by limiting all destructive (ground disturbing) activities to areas outside the site boundary. If avoidance can not be accomplished, construction activities should be monitored by a professional archaeologist.

7.4.4 Previously Recorded Sites

Twelve previously recorded sites were noted in the NMCRIS review for lying near but not within the Roswell site. A brief description of each of these sites is presented in Table 7-2. Most of these sites consist of artifact scatters, some with fire-cracked rock. The cultural affiliation of each site is either unknown, Archaic, or Mogollon. Causey Ranch (site LA 43747) is an historic ranch that is also listed on the New Mexico State Register of Cultural Properties. This historic ranch site (7-034) dating from the late 1800s and early 1900s is shown as being outside the Roswell site. The site may be misplotted and appears to lie outside of its given location. As both locations are outside of the Roswell site, they were not revisited and the precise location of Causey Ranch is undetermined.

Another site listed on New Mexico's State Register of Cultural Properties is known as the "Mescalero Sands Archaeological District." In general, the "Mescalero Sands" refers to a band of wind-deposited sand and sand dunes of variable width that extends north-south along the western edge of the Mescalero Ridge escarpment (7-008). The Mescalero Sands Archaeological District does not impinge upon the private lands within the Roswell site.

Table 7-2. Previously recorded sites near the Roswell site.

Site (LA)	Site Type	Age	Recording Agency
32238	Non-structural, multi-component	Unknown, Archaic, Mogollon	Lea County Archaeological Society
32239	Non-structural, multi-component	Unknown, Paleoindian, Mogollon	Lea County Archaeological Society
32240	Structural, multi-component	Unknown, Archaic, Mogollon	Lea County Archaeological Society
43747	Structural	Historic (Causey Ranch House)	ARMS (also listed on the State Register)
45859	Non-structural	Unknown	Eastern New Mexico University (7-029)
99419	Non-structural	Mogollon	Pecos Archaeological Consultants (7-004)
99421	Non-structural	Mogollon	Pecos Archaeological Consultants (7-004)
99422	Non-structural	Mogollon	Pecos Archaeological Consultants (7-004)
99423	Non-structural	Unknown	Pecos Archaeological Consultants (7-004)
99424	Non-structural	Unknown	Pecos Archaeological Consultants (7-004)
99425	Non-structural	Mogollon	Pecos Archaeological Consultants (7-004)
99427	Non-structural	Unknown	Pecos Archaeological Consultants (7-004)

One site (site LA 32239) with an unspecified Paleoindian component is found near the Roswell site. Seven of the 12 sites were recorded in 1992 during a geophysical survey (7-004). One site is listed (7-029) and information is only available for the four other sites on the NMCRIS database, with three of those sites having been recorded by the Lea County Archaeological Society (see also 7-018, 7-031). A thirteenth site, site LA 32240, is also linked with the Pecos National Historical Park inventory (NMCRIS Activity Number 58108) but this linkage is probably erroneous as a result of number transposition from the original site LA 32440 (PECO No. 528) that is included in a related reference (7-024).

7.4.5 Isolated Occurrences

Fifty-seven isolated occurrences (IO Numbers 1 though 57) were located during the current Class III inventory. The location of each IO was calculated using a Trimble GeoXT GPS unit with sub-meter accuracy and recorded with the UTM coordinates in NAD 27, Zone 13 North projection. Recording of each IO exhausts the information potential of that item; none of the IOs possess the criteria that make them eligible for listing to the NRHP and further analysis of these IOs would not yield additional information. The IOs are presented in Table 7-3. Many of the lithic artifacts identified as unknown for temporal affiliation may well be related to adjacent sites where the predominant temporal affiliation was Jornada Mogollon. Jornada Brown dominates the ceramic inventory although a few pieces of Chupadero black-on-white were located both within the drawn confines of archaeological site boundaries or as an IO (Number 57). An Archaic presence is also conceivable but is not demonstrable on the basis of the surface assemblage.

Table 7-3. Isolated occurrences.

Number	Temporal Affiliation	Description
1	Unknown	1 brown chert flake
2	Unknown	1 basalt core
3	Unknown	1 quartzite flake
4	Unknown	1 white quartzite flake
5	Unknown	1 milky white core with retouch
6	Unknown	1 brown chert scraper
7	Unknown	1 quartzite core
8	Unknown	1 brown sherd
9	Unknown	1 chert flake
10	Unknown	1 black retouched flake
11	Unknown	1 red chert flake
12	Unknown	1 chert scraper
13	Unknown	1 basalt flake
14	Unknown	3 chert flakes
15	Unknown	2 chert flakes

Table 7-3. (continued).

Number	Temporal Affiliation	Description
16	Unknown	1 chert flake
17	Unknown	1 chert flake
18	Unknown	1 chert flake
19	Unknown	1 chert flake
20	Unknown	1 chert flake
21	Unknown	1 chert flake
22	Unknown	1 chert cobble core
23	Unknown	1 chert flake
24	Unknown	1 chert flake
25	Unknown	1 chert flake
26	Jornada Mogollon	1 brown sherd
27	Jornada Mogollon	1 brown sherd
28	Unknown	1 chert flake
29	Unknown	1 chert flake
30	Unknown	2 chert flakes
31	Unknown	1 chert flake
32	Unknown	1 chert flake
33	Jornada Mogollon	1 corrugated sherd
34	Unknown	1 chert flake
35	Unknown	1 chert flake
36	Unknown	1 chert flake
37	Unknown	1 quartzite retouched core
38	Unknown	1 quartzite retouched core
39	Unknown	1 chert flake
40	Unknown	1 chert flake
41	Unknown	1 chert flake
42	Unknown	1 chert flake
43	Unknown	1 chert flake
44	Unknown	1 chert flake

Table 7-3. (continued).

Number	Temporal Affiliation	Description
45	Unknown	1 quartzite flake
46	Unknown	1 chert flake
47	Unknown	1 chert retouched flake
48	Historic/Modern	Modern can dump
49	Unknown	1 edge retouched uniface
50	Unknown	1 chert flake
51	Unknown	Fire-cracked rock concentration
52	Unknown	1 chert flake
53	Historic/Modern	2 historic sherds
54	Historic/Modern	Modern can dump
55	Historic/Modern	Modern can dump
56	Historic/Modern	Historic dump 1907-1920
57	Jornada Mogollon	2 chert flakes and 1 Chupadero black-on-white sherd

7.5 Evaluations and Recommendations

This section presents the NRHP eligibility and management recommendations for the sites. The recommendations are presented in detail below. None of the IOs is recommended for inclusion on the NRHP. The criteria of eligibility for each resource to be considered for inclusion on the NRHP were discussed in Section 7.3.4.

7.5.1 Cultural Resource Eligibility Evaluations

The 10 newly recorded sites were evaluated according to the criteria of eligibility for inclusion on the NRHP Table 7-4 summarizes the NRHP eligibility and management recommendations for the newly recorded cultural sites. Sites LA 155725, 155726, and 155728 are recommended as eligible for listing to the NRHP. All three of these sites are eligible for their information potential (Criterion D). These sites should be avoided by all ground disturbing activities proposed by the current undertaking. If avoidance can not be achieved during the construction of Roswell site facilities, it is recommended that additional archaeological activities (e.g., excavations) be completed in the construction areas and that any ground disturbance activity be monitored by a professional archaeologist in order to document any subsurface cultural manifestations, including features and artifacts. The other seven sites are potentially eligible for listing to the NRHP because of the possibility of buried cultural deposits within the sand dune depositional environment. Because of their potential eligibility, these sites should also be avoided. None of the IOs is recommended for inclusion on the NRHP.

No previously recorded sites were identified within the Roswell site boundary during the NMCRIS/ARMS records check. Twelve sites were found to be near, but not within, the Roswell site. These have been discussed above in Section 7.4.4 and are not expected to be affected by the project.

Table 7-4. Summary of NRHP and management recommendations.

Site Number	NRHP Recommendation	NRHP Eligibility	NRHP Criteria
LA 155719	Potentially eligible	Potentially	D
LA 155720	Potentially eligible	Potentially	D
LA 155721	Potentially eligible	Potentially	D
LA 155722	Potentially eligible	Potentially	D
LA 155723	Potentially eligible	Potentially	D
LA 155724	Potentially eligible	Potentially	D
LA 155725	Eligible	Eligible	D
LA 155726	Eligible	Eligible	D
LA 155727	Potentially eligible	Potentially	D
LA 155728	Eligible	Eligible	D

7.5.2 Control of Ground Disturbing Activities

If avoidance of each site can be achieved, a recommendation of "no historic properties affected" is recommended by the cultural resource investigators for the undertaking. If avoidance cannot be carried out, then any ground disturbing activity needs to be monitored by a professional archaeologist. These recommendations are made for the Roswell site subject to the following additional stipulations to eliminate direct impact to significant resources:

1. All disturbances should be restricted to locations within the current inventoried Roswell site.

2. Due to the nature of the sites located during the survey and the probability that subsurface cultural deposits exist below the surface in areas away from where surface manifestations have been recorded and that cultural material is actively being eroded out of sand dune formations, the construction activity should be monitored by a professional archaeologist.

3. If evidence of additional prehistoric or historic sites is discovered during ground disturbing activities, all activities within a 100-foot radius of the site(s) should cease immediately and appropriate DOE personnel should be notified to assure proper handling of the discovery by qualified archaeological personnel.

4. All construction and maintenance personnel should be instructed of the confidentiality of site location information and that the collection of cultural materials is prohibited.

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CONTENTS

FIGURES

8. FUTURE PROJECTS

This section describes any known federal and non-federal projects within 5 miles of the outer perimeter of the Roswell site that may contribute to the cumulative environmental impacts of the Roswell site. There are no cities or towns within 6 miles and consequently there are no plans for commercial, residential, or industrial projects. There is one industrial facility approximately 1 mile north of the Roswell site, but there are no current plans for expansion or additions to the facility.

- The only known projects in Chaves County are the installation of a cellular transmission tower approximately 1 to 2 miles northeast of the Roswell site and the installation of a liquefied petroleum gas (LPG) transfer line booster pump station located on Mescalero Ridge.

- Mr. Robert W. Marley owner of land along the Mescalero Ridge has given consideration to developing a wind farm on his property, but has no firm plans to implement the project.

8.1 Known and Foreseeable Federal and Non-Federal Projects

The Director of the Chaves County Planning Commission in Roswell was contacted to identify any known and reasonably foreseeable federal and non-federal projects and other actions in the vicinity of the Roswell site. The only known and approved projects are:

1. Z 2007-1 is the installation of a cellular transmission tower on Mescalero Ridge (8-001). This is located approximately 1 to 2 miles northeast of the proposed Roswell site in Section 3, Township 11 South, Range 31 East.

2. Z 2007-2 is the installation for a LPG transfer line booster pump station (8-002) also located on Mescalero Ridge on land owned by Mr. Jack Luce.

Both planned project locations are shown relative to the Roswell site in Figure 8-1. Additionally, Mr. Robert W. Marley the landowner has previously given consideration to developing a wind farm on his land along the Mescalero Ridge to generate electrical power. However, there are currently no firm plans to implement this project.

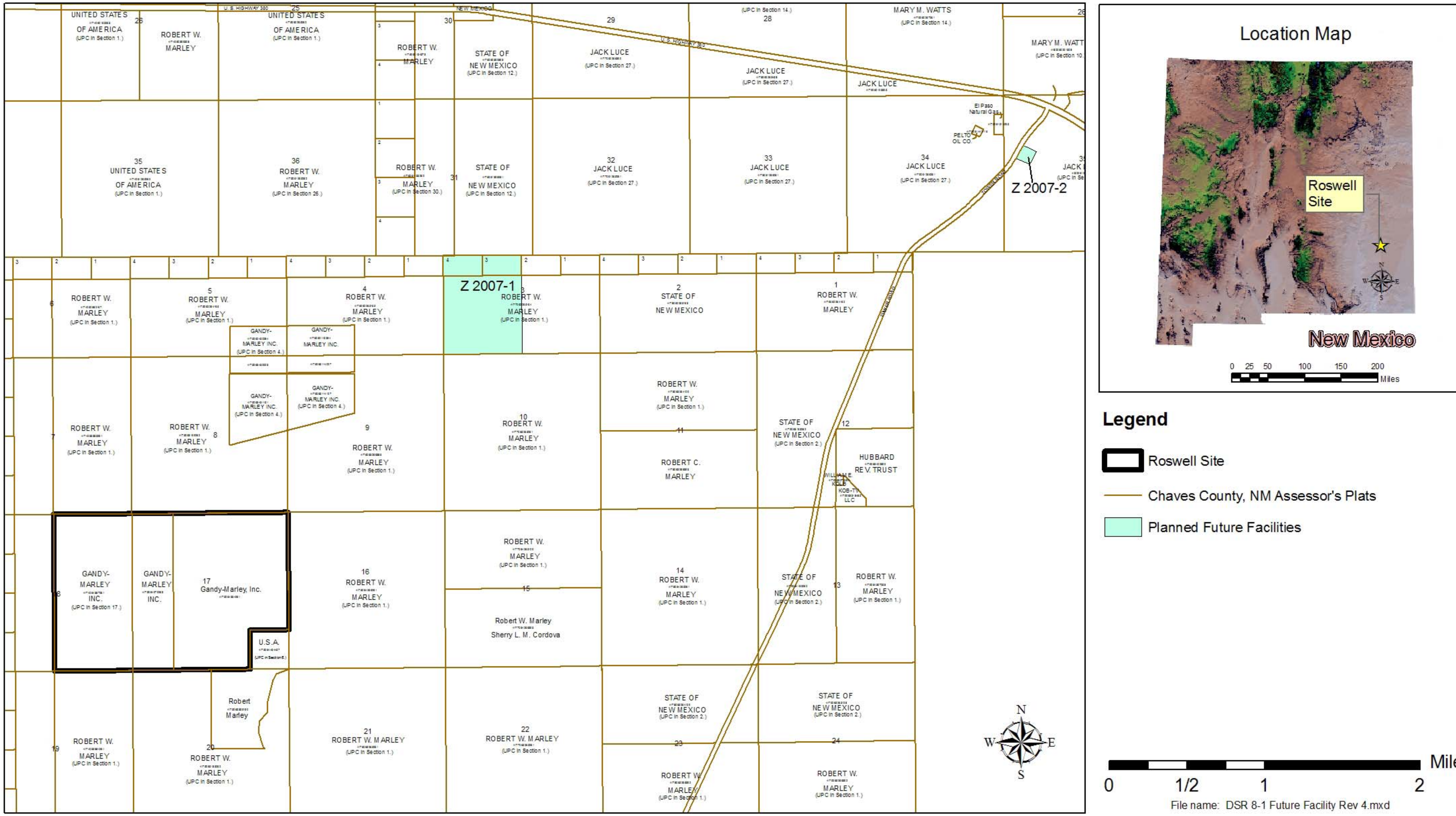

Figure 8-1. Landowners and planned future projects near the Roswell facility (8-003, 8-004).

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CONTENTS

FIGURES

TABLES

9. GEOLOGY AND SEISMOLOGY

In order to facilitate comparison with regulatory requirements, this section follows the organization of "Seismic and Geologic Siting Criteria for Nuclear Power Plants – Required Investigations" (9-031). It includes an overview and summary (Section 9.1), a description of the geologic setting and geologic history of the site (Section 9.2), an analysis of seismic hazards due to vibratory ground motion and surface faulting in the site vicinity (Section 9.3), and a brief discussion of seismically induced floods and waves (Section 9.4). Information about foundation conditions is provided in Section 9.3.1.4.

The geologic and seismologic characteristics of a potential site for nuclear facilities receive careful consideration during site selection and facility design. The majority of the reactor site criteria (10CFR100) pertain to the geologic and seismologic characteristics of potential reactor sites. As a result of the emphasis placed on these characteristics, this section provides sufficient information about the regional and site-specific geologic and seismic characteristics needed to support a detailed safety analysis.

9.1 Overview and Summary

The Roswell site is located approximately 40 miles east of Roswell, New Mexico in the Pecos River Valley Section of the Great Plains Physiographic Province. Terrain within this province ranges from low-lying plains to rugged canyons. In the area near the Roswell site, the terrain is characterized as a low-relief topography consisting of hummocky eolian deposits, sand ridges and dunes. The site encompasses 920 acres and slopes moderately from east to west from an elevation of 4,260 feet above sea level to 4,120 feet above sea level.

The fine textured sediments beneath the site do not yield large quantities of groundwater, although a thin basal sandstone in the lower portion of the Triassic sediments yields low quality groundwater near the site. In contrast, the aquifer in the Ogallala Formation east of the site is a major source of high quality groundwater in the region. Groundwater near the City of Roswell, about 40 miles west of the site, is obtained from an alluvial aquifer near the Pecos River and from limestones and dolomites at greater depth. Fine-textured rocks and evaporites in Triassic and Permian formations hydraulically isolate the aquifers near the City of Roswell from the site and the Ogallala aquifer east of the site.

Information contained within Section 9 provides the basis for the following characterization of the Roswell site's geology and seismology:

- The site is set in a location of primarily Triassic and Permian sediments that were emplaced in both marine and non-marine depositional environments. The combined thickness of these sediments is approximately 9,000 feet at the site. A relatively thin veneer of Quaternary eolian deposits, ranging in thickness from a few feet to as much as 60 feet, overlies these sediments.

- There are no surface faults within or adjacent to the project site. Furthermore, no faults were identified in the underlying Triassic sediments during the most recent drilling study. There are no mapped faults located within 50 miles of the site in any direction.

- The nearest tectonic center to the site is the Rio Grande Rift, approximately 100 to 200 miles west of the site. There have been no earthquakes of magnitude (Ma) 3 or larger in either the pre-instrumental or instrumental time periods within 50 miles of the site.

- Of the 101 faults located within a 200-mile radius of the site, only eight faults exceeded the minimum length specified by Appendix A of 10 CFR 100. Six of these eight were deemed to be capable.
- The closest significant rift-related fault is 123 miles from the site.
- No site-specific evidence of subsurface material failure during previous earthquakes was observed during previous characterization studies at the site.
- Predicted ground motion values are relatively low (peak ground acceleration 0.01 to 0.05 times gravity [g] for 10 percent probability of exceedance in 50 years; 0.04 to 0.12 g for 2 percent probability of exceedance in 50 years).
- Owing to the physical properties of soils in the site location, foundation conditions are straightforward.

9.1.1 Geology Overview

A generalized conceptual model is presented here as an introduction to the geologic setting of the site. The site is located about 1 mile west of Mescalero Ridge, a prominent geographic feature in southeastern New Mexico where the ground surface elevation abruptly rises about 200 feet from west to east. The site is west of the escarpment, where the ground surface slopes gently toward the Pecos River about 30 miles west of the site. A thin veneer of soils overlies bedrock at the site. The sedimentary bedrock beneath the site is primarily fine-textured clastic rocks (mudstones) of the Triassic-age Dockum formation, with sediments and evaporites of Permian age formations at greater depth (see Figure 9-1). Younger Tertiary age sediments of the Ogallala Formation are not present at the site, but are present east of Mescalero Ridge. The Ogallala sediments form a resistant caprock that protects the underlying Triassic sediments from erosion.

9.1.2 Seismology Overview

The site has been relatively stable in recent geologic time. The Permian, Triassic, and Tertiary sediments are all relatively flat-lying, dipping about one degree to the east, and do not appear to have been deformed substantially by tectonic events. The major structural feature closest to the site, the Rio Grande Rift, is more than 100 miles west of site. No faults or folds that have been active in Quaternary time are near the site. The closest capable fault is over 100 miles from the site. Although earthquakes have occurred within 200 miles of the site, primarily along known, mapped faults associated with the Rio Grande Rift, no sizeable earthquakes have occurred within 50 miles of the site in historic times. The lack of nearby capable faults and the absence of nearby earthquakes result in the site being in an area of low seismic risk, as indicated by the low predicted ground surface accelerations (Figure 9-2).

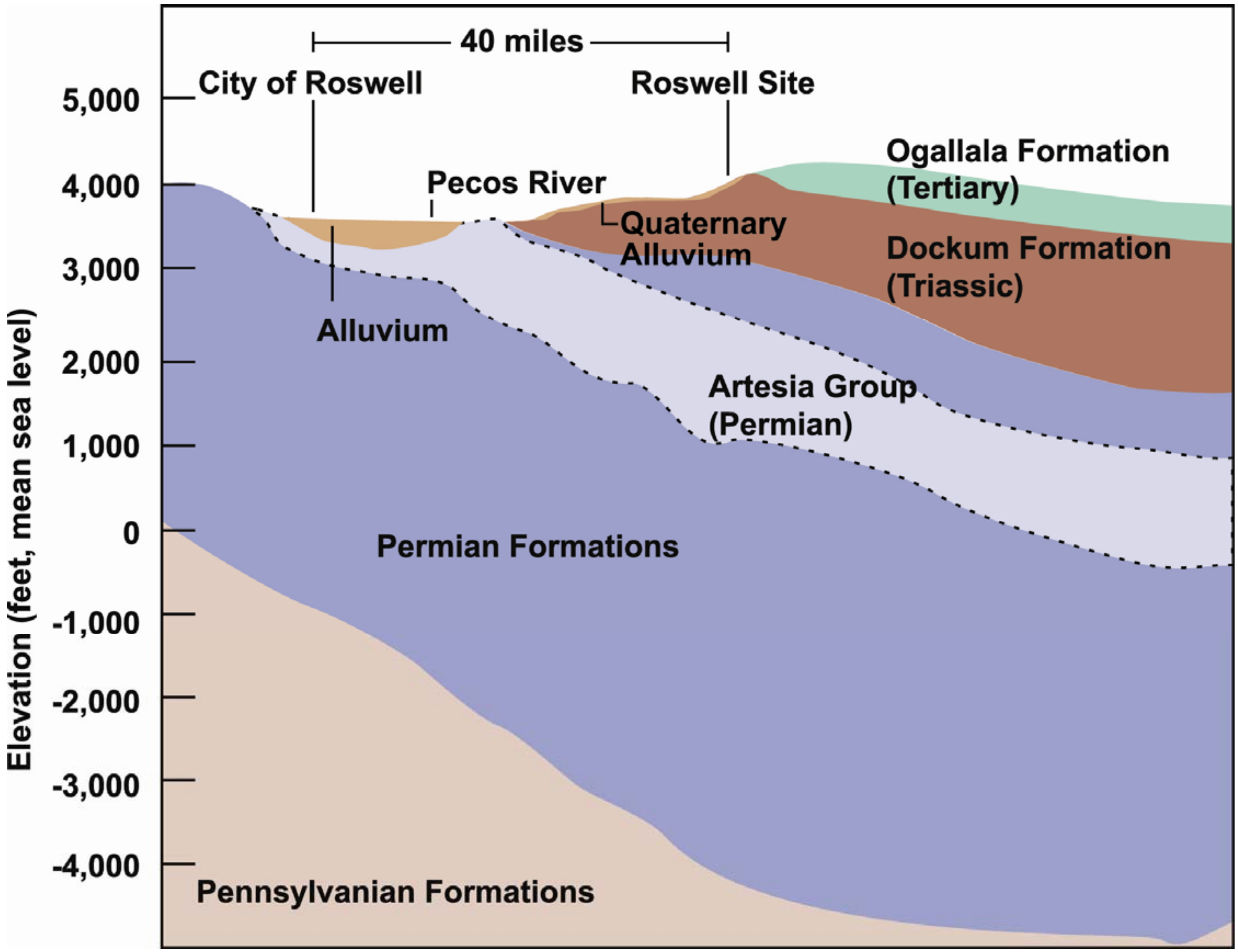


Figure 9-1. Generalized cross section of the site area.

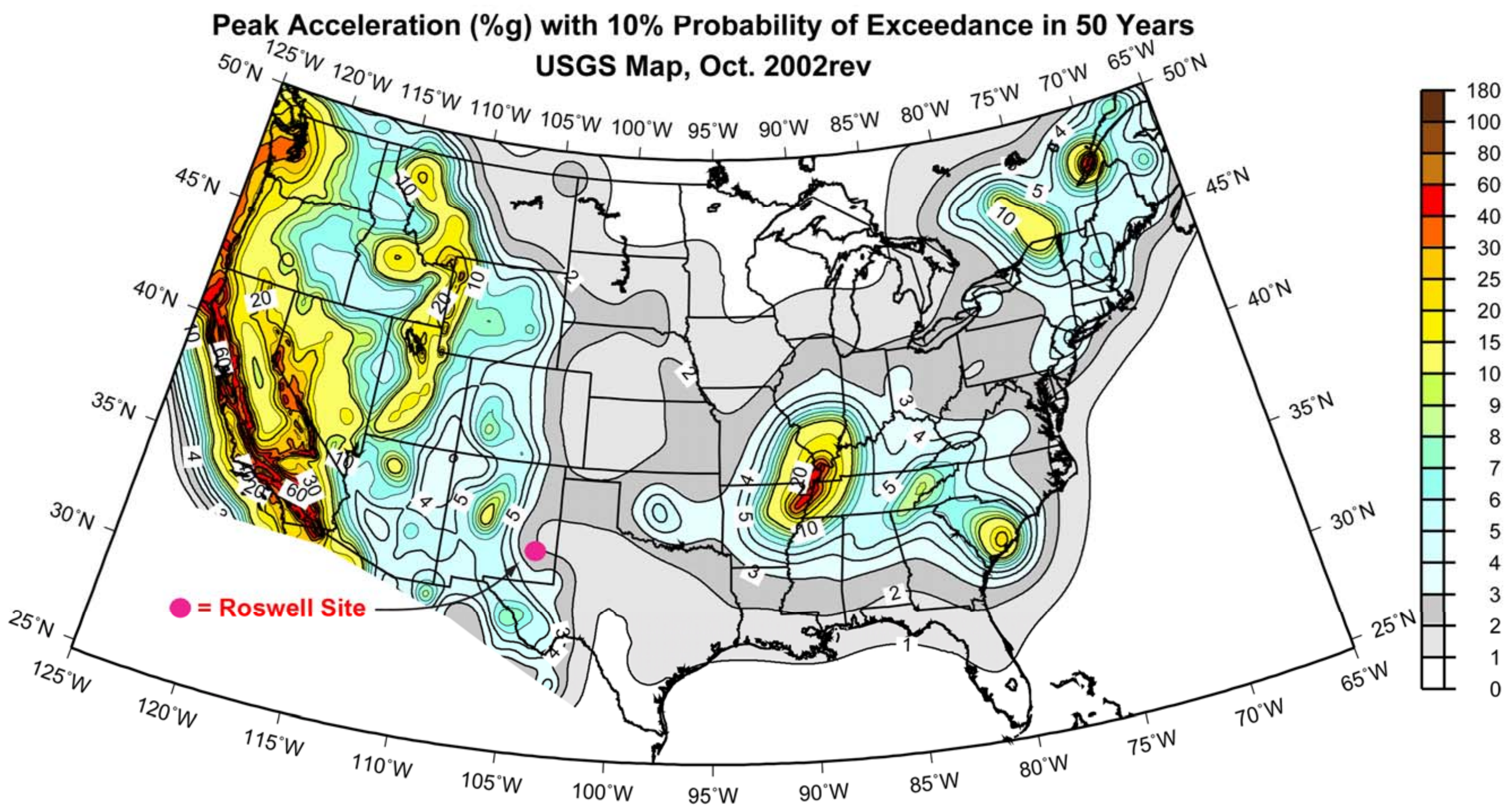


Figure 9-2. Predicted ground surface accelerations (9-023).

9.2 Geologic Setting

This section provides a summary of the geologic setting of the site. Included are descriptions of the lithologic, stratigraphic, and structural geologic conditions of the site and the surrounding region. The information in this section was obtained primarily from the site characterization studies undertaken during the 1990s, on behalf of Gandy-Marley, Inc., in support of the Triassic Park HWDF permit application (9-009). These studies included a thorough review of existing data and reports, of which the primary focus was to assess the character of the underlying Triassic sediments at the site in the context of their suitability for hosting a hazardous waste disposal facility. The study also included a detailed site geologic and hydrologic characterization effort. *The Depositional Framework of the Lower Dockum Group (Triassic)* (9-003) was used as the primary reference for the description of the geologic setting.

This section provides a summary of the previous studies that describe the stratigraphy, hydrologic setting, and structure of sedimentary rocks at the site. Sections 9.2.1 through 9.2.4 provide information requirements identified in 10 CFR 100, Appendix A IV (1). Section 9.2.5 provides information on potential mineral resources in the area.

9.2.1 Regional Geologic Setting and Geologic History

The site is located approximately 40 miles east of Roswell, New Mexico, in the Pecos River Valley Section of the Great Plains Physiographic Province (Figure 9-3). The Pecos River Valley Section is bordered by the High Plains section to the east, the Raton Section to the north, the Edwards Plateau Section to the south, and the Sacramento Section of the Basin and Range Province to the west. The terrain throughout the Pecos River Valley Section ranges from low-lying plains to rugged canyons. Locally, the terrain is characterized a low-relief topography consisting of hummocky eolian deposits, sand ridges, and dunes. The site encompasses 920 acres and slopes moderately from east to west, from an elevation of 4,260 feet above sea level at its eastern boundary to 4,120 feet above sea level along its western boundary. The site extends 1.5 miles in the east-west direction.

The site is set in a location of primarily Permian and Triassic sediments, which were emplaced in both marine and non-marine depositional environments. The combined thickness of these sediments is approximately 9,000 feet at the site. The Triassic sediments are overlain with a veneer of Quaternary eolian deposits. Tertiary sediments above the Triassic sediments form the caprock east of Mescalero Ridge, which lies about 1 mile east of the site.

The site is located on the Northwestern Shelf of the Permian age Delaware Basin. During the late Pennsylvanian and early Permian, the area underwent intense deformation during the collision of the Gondwanaland and Laurussia plates, forming the Ouachita-Marathon orogeny (Figure 9-4). Throughout the remainder of the Permian, a long period of tectonic quiescence transpired, during which the area underwent subsidence and erosion. The sea eventually encroached upon the area and occupied broad eroded surfaces and truncated edges of previously deposited strata. Throughout the remainder of the Permian, the Delaware Basin filled with thousands of feet of sediments and evaporites. The Delaware Basin includes the basin itself, fore-reef deposits, reef deposits, and back-reef deposits. The site is located on the Northwestern Shelf (i.e., back-reef) of the Delaware Basin. During periods of highstands (periods of relatively high sea level) and lowstands (periods of relatively low sea level), different facies developed on the back-reef shelf. During highstand intervals, carbonate-evaporite-redbed deposits were formed on the northwestern shelf of the Delaware Basin. Lowstand intervals resulted in the deposition of clastic terrigenous sediments (Figure 9-5). Thus, the stratigraphy of the Permian Northwestern Shelf includes both marine and terrigenous sediments. These sediments are described in Section 9.2.2.

During the Triassic, regional uplift occurred that resulted in the formation of an enclosed fluvial basin to the east of the site (Figure 9-6). This basin received sediments from the east, south, and west (Figure 9-7). The Triassic sediments were fed into this basin through a range of fluvial and lacustrine depositional systems including lobate and fan deltas, braided streams, meandering streams, and lakes. The sediment types range from conglomerate to mudstone, depending on the energy of the depositional environment. These sediments formed what is known as the Dockum Group in Texas and New Mexico. The Dockum Group consists of 200 to 2,000 feet of sediments ranging from conglomerate to mudstone that were primarily derived from Paleozoic sedimentary rocks. Note that the site is in an area where the Triassic sediments are less than 30 percent sand, which suggests that their hydraulic conductivity is low (groundwater hydrology of the site is discussed in Section 3.1). These sediments are described in Section 9.2.2.

Uplift associated with the compressive Laramide orogeny occurred in the region during the Tertiary era, which resulted in the gentle eastward tilting of pre-Tertiary rocks in eastern New Mexico. During the Jurassic and Cretaceous, the area once again underwent erosion. During the Tertiary, clastic sediments were deposited over the eroded Triassic surface. These sediments were derived from the west and formed a flat-lying sandstone and conglomeritic unit. This Tertiary unit is known as the Ogallala formation and unconformably overlies the Triassic Dockum Group. In the vicinity of the site, the Ogallala formation extends eastward from Mescalero Ridge, which lies approximately 1 mile east of the site. The Laramide tectonic activity continued into the late Paleocene.

Following the Laramide tectonics, the area experienced a period of volcanism between 28 and 38 million years ago. During this time, the increased geothermal gradient provided the impetus for the transformation of Pennsylvanian-Mississippian organic deposits into petroleum reserves. In addition, the sulfides released from the Pennsylvanian-Mississippian petroleum basins produced the reducing fronts that were responsible for the formation of Mississippi-Valley-Type mineral deposits. During the Miocene, Basin and Range extension commenced and the Rio Grande Rift was formed in central New Mexico. Coincidental with the Basin and Range extension was the epeirogenic uplift of the Colorado Plateau and the High Plains province leading to the present elevation of this region.

During the Quaternary, the area has experienced erosion and deposition of eolian sediments and tectonic quiescence. The Quaternary sediments form a thin mantle over the underlying Triassic Dockum Group sediments. A generalized stratigraphic column of the Delaware Basin and nearby areas is depicted in Figure 9-8.

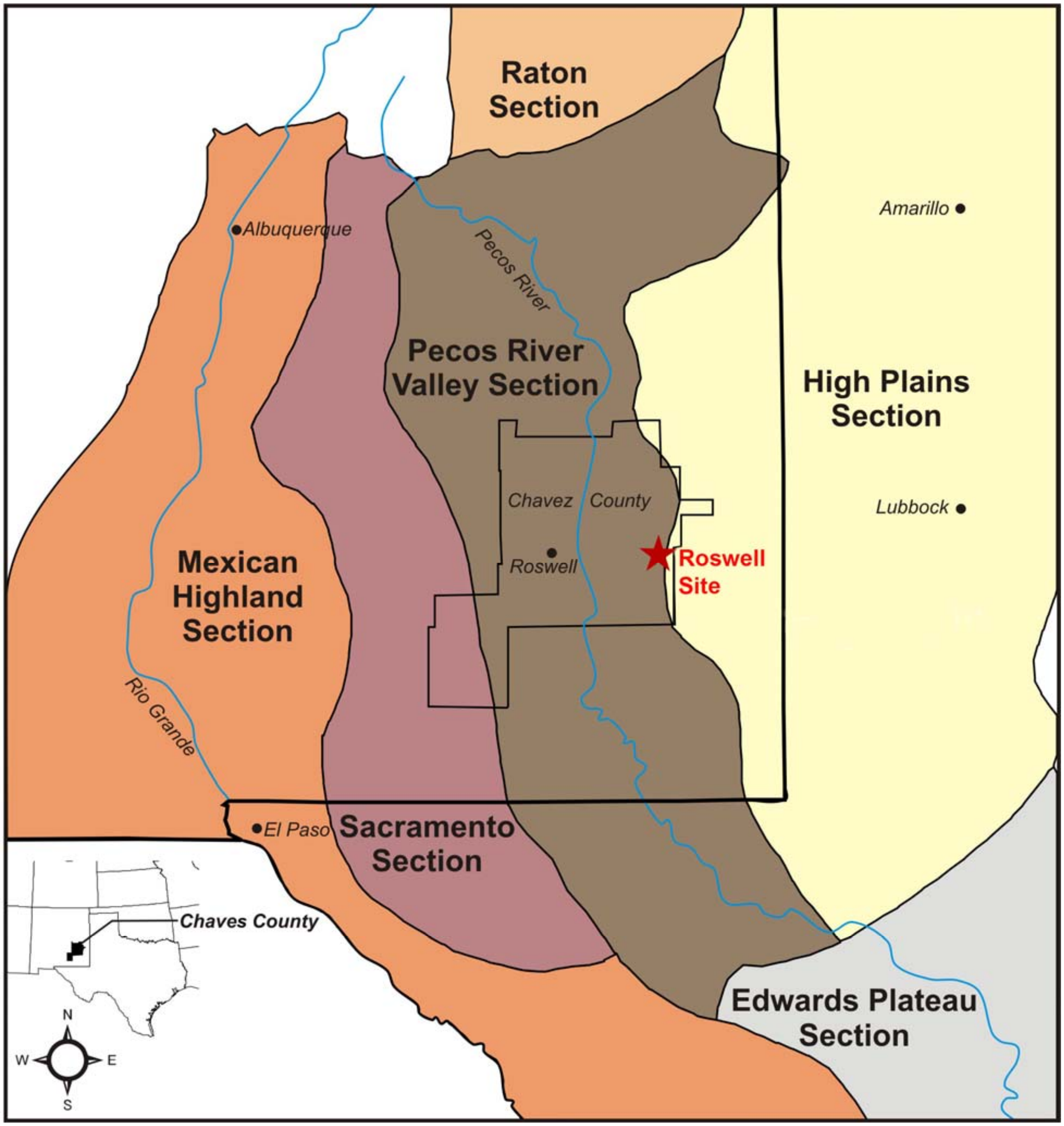


Figure 9-3. Site location and physiographic province setting (9-033).

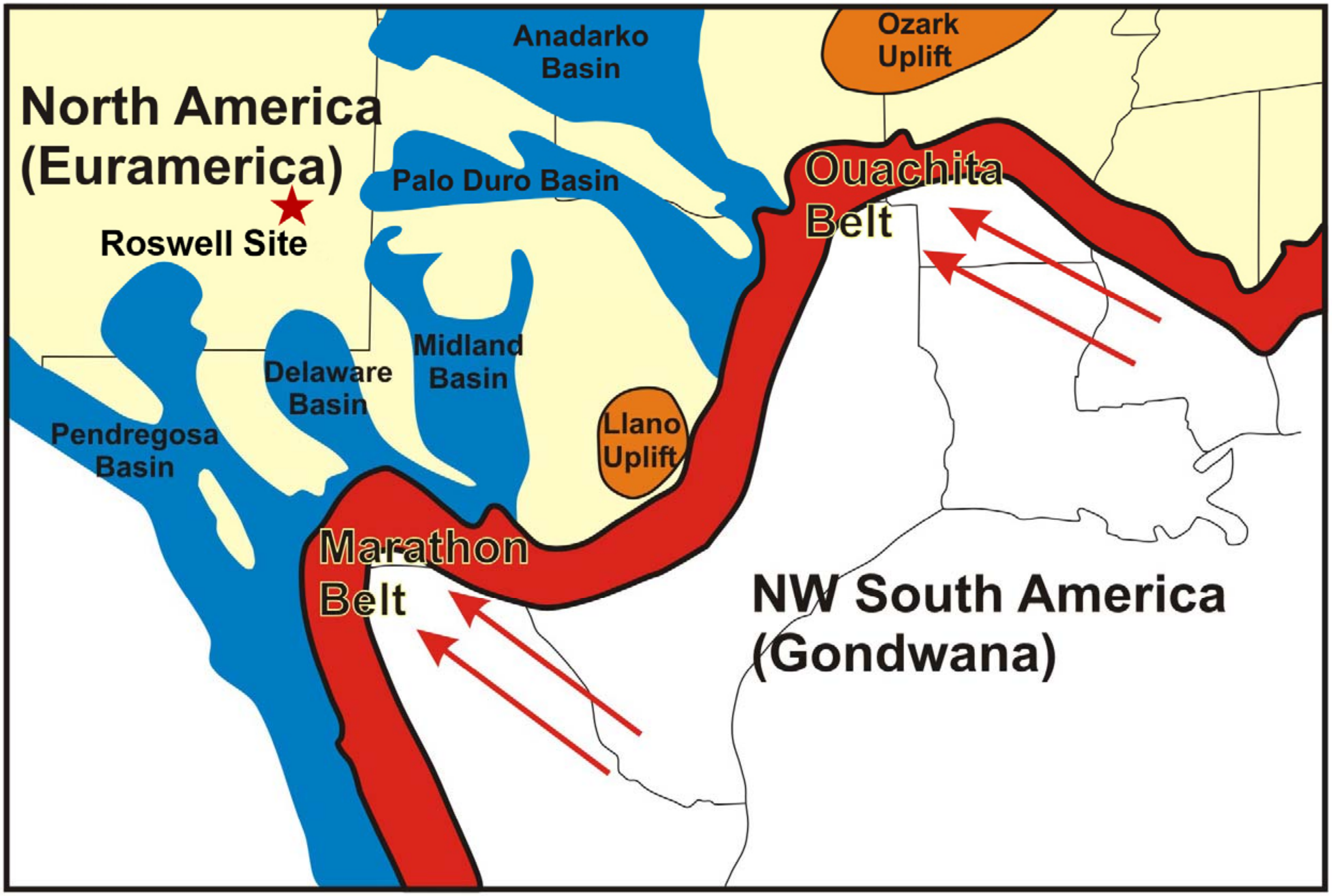


Figure 9-4. Pennsylvanian-Permian Tectonics (9-046).

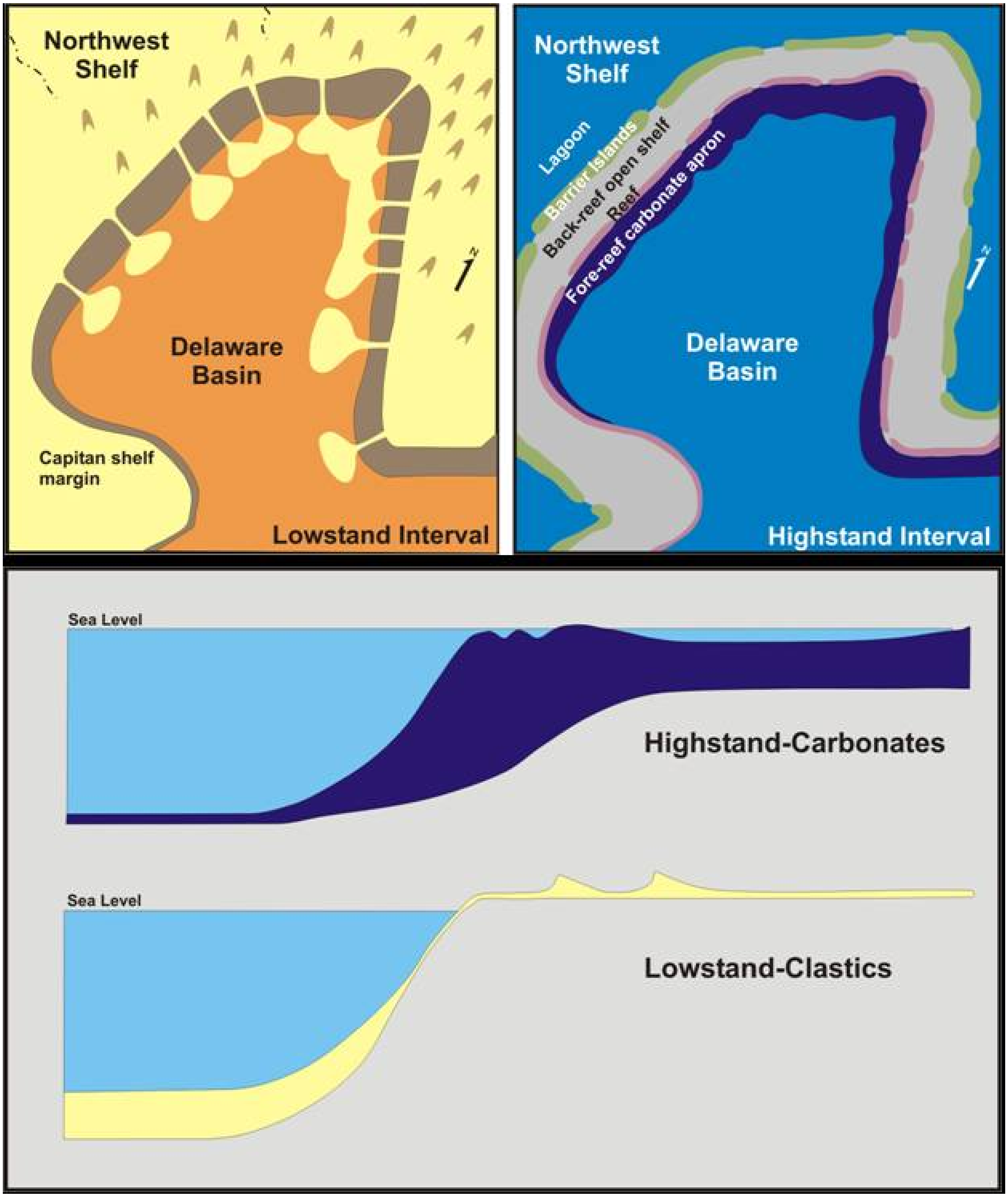


Figure 9-5. Depositional model of the Delaware Basin (9-046).

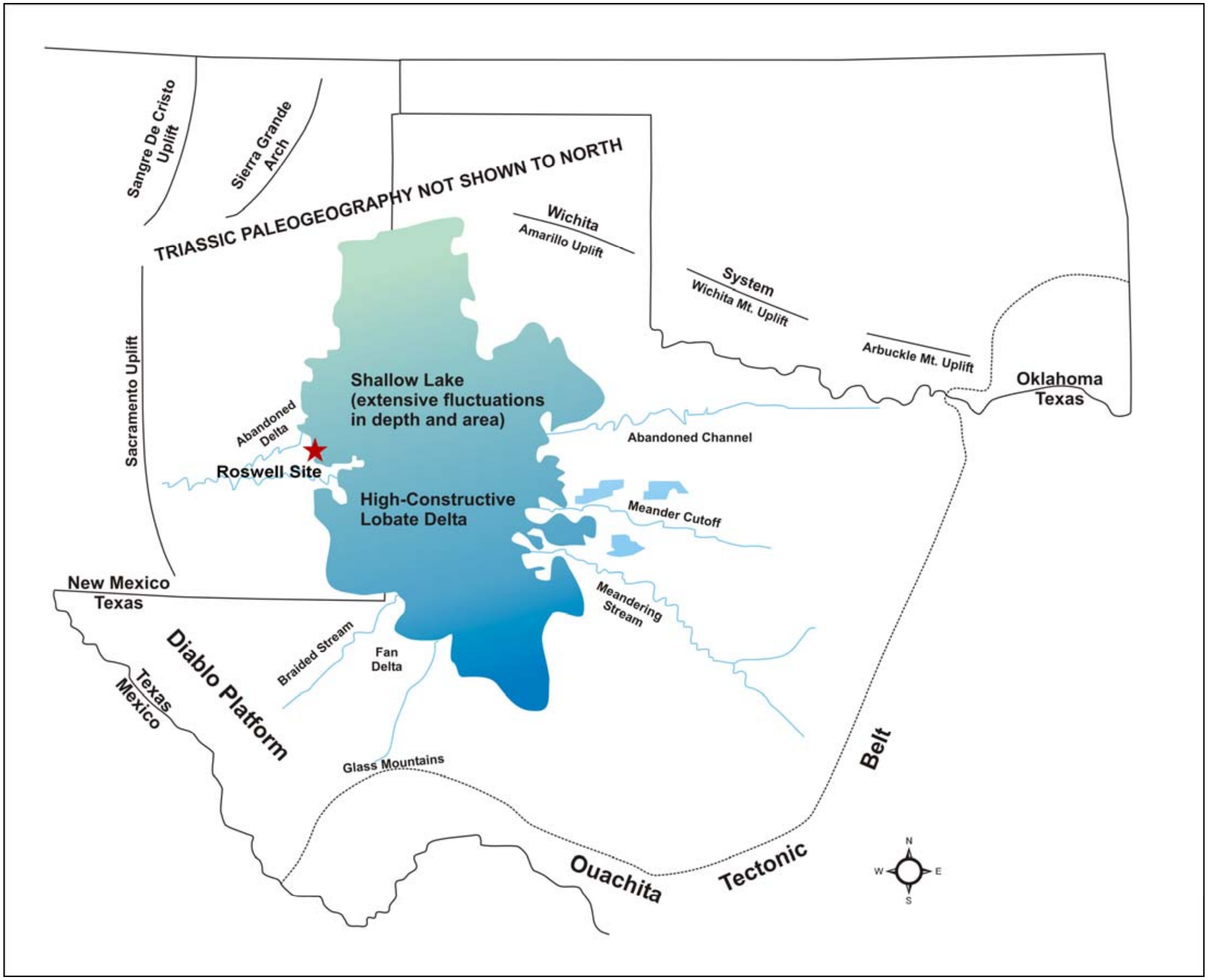


Figure 9-6. Triassic paleogeography of western Texas and eastern New Mexico (9-003).

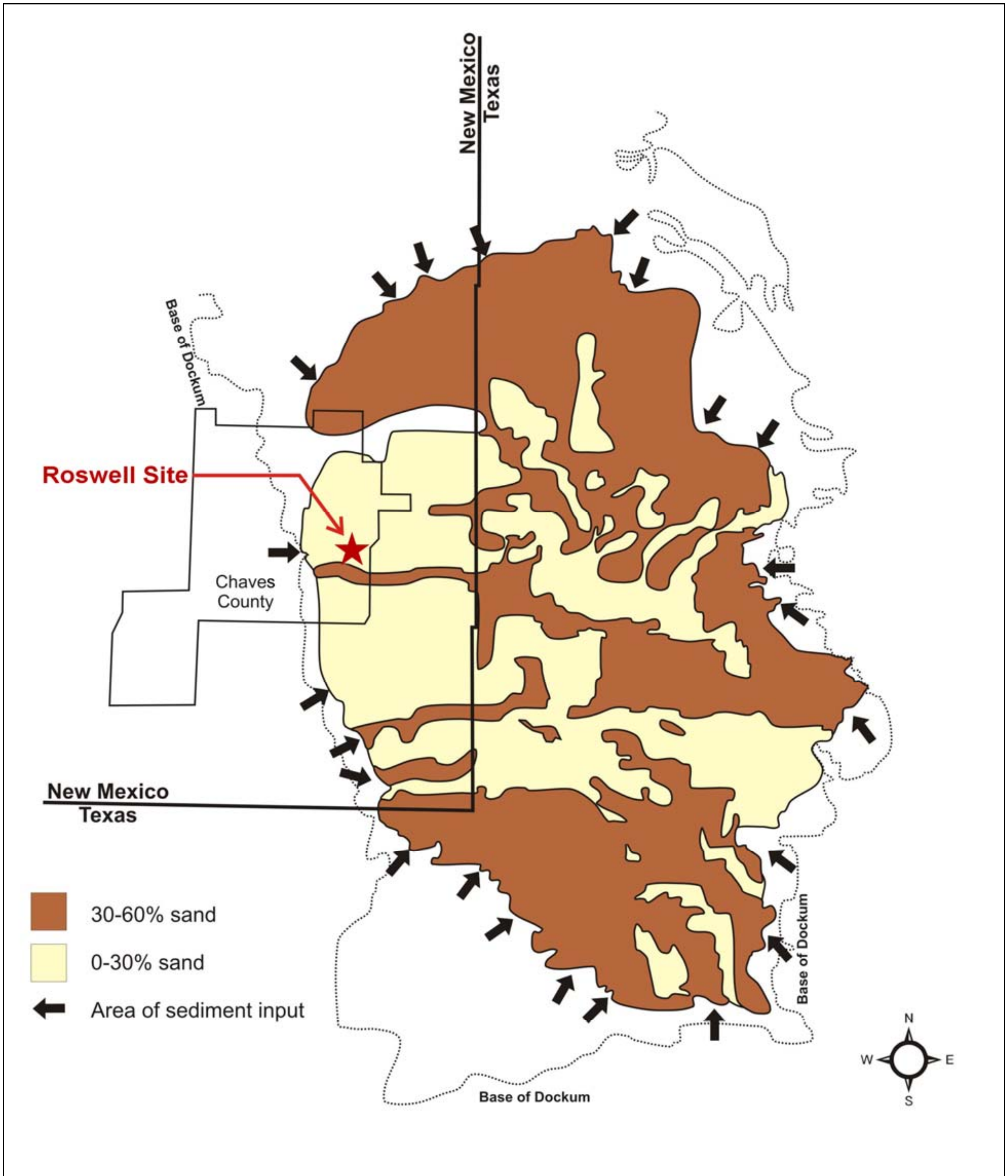


Figure 9-7. Triassic sedimentation in western Texas and eastern New Mexico (9-003).

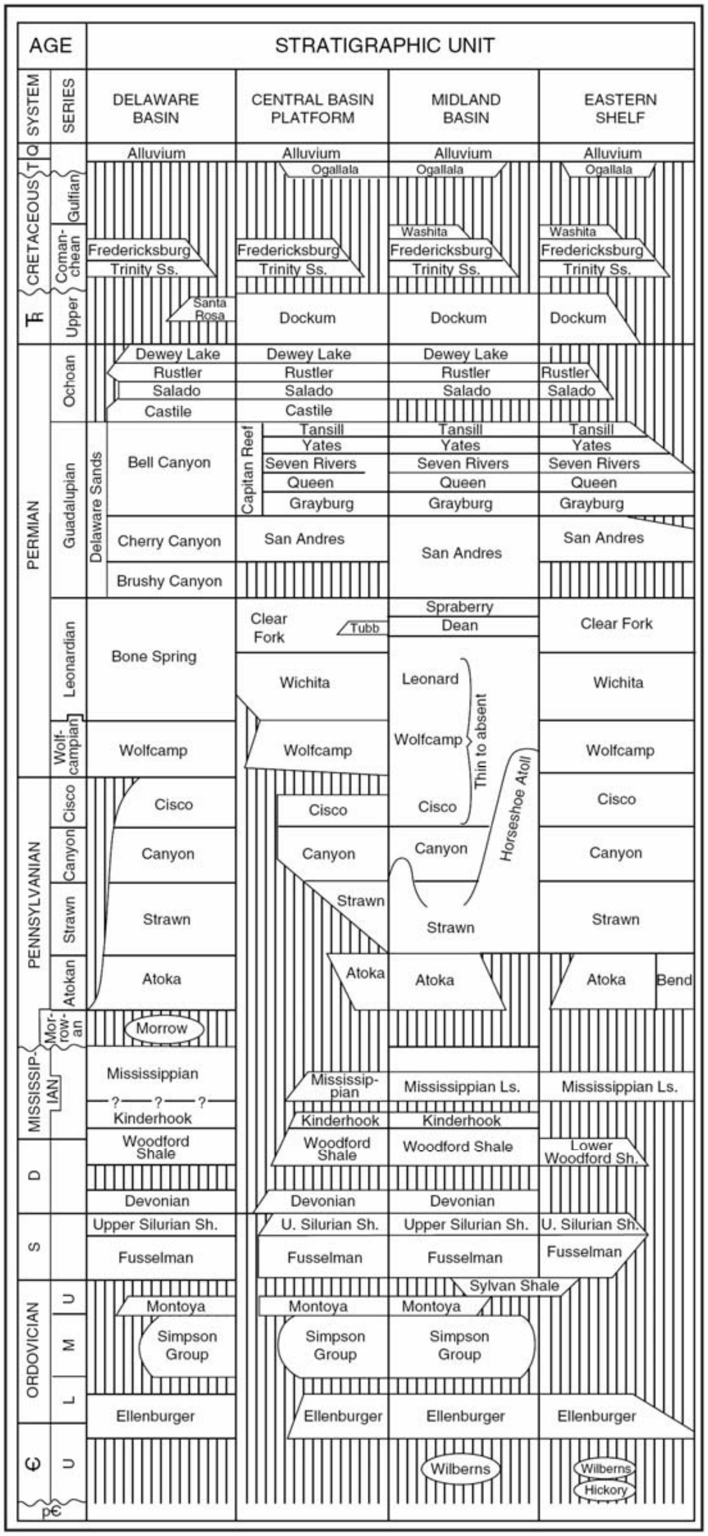


Figure 9-8. Regional stratigraphy of the Delaware Basin (9-046).

9.2.2 Stratigraphic Units at the Roswell Site

This section provides a summary of the site stratigraphy and lithology. Sediments at the site vicinity include (from younger to older) Quaternary eolian sediments, the Tertiary Ogallala Formation, the Triassic Dockum Group, and Permian sediments (Figure 9-9). A generalized geologic map of the site area is depicted in Figure 9-10. In addition, a generalized cross section of the site area is given in Figure 9-11. The geologic units are discussed below, in order from younger to older.

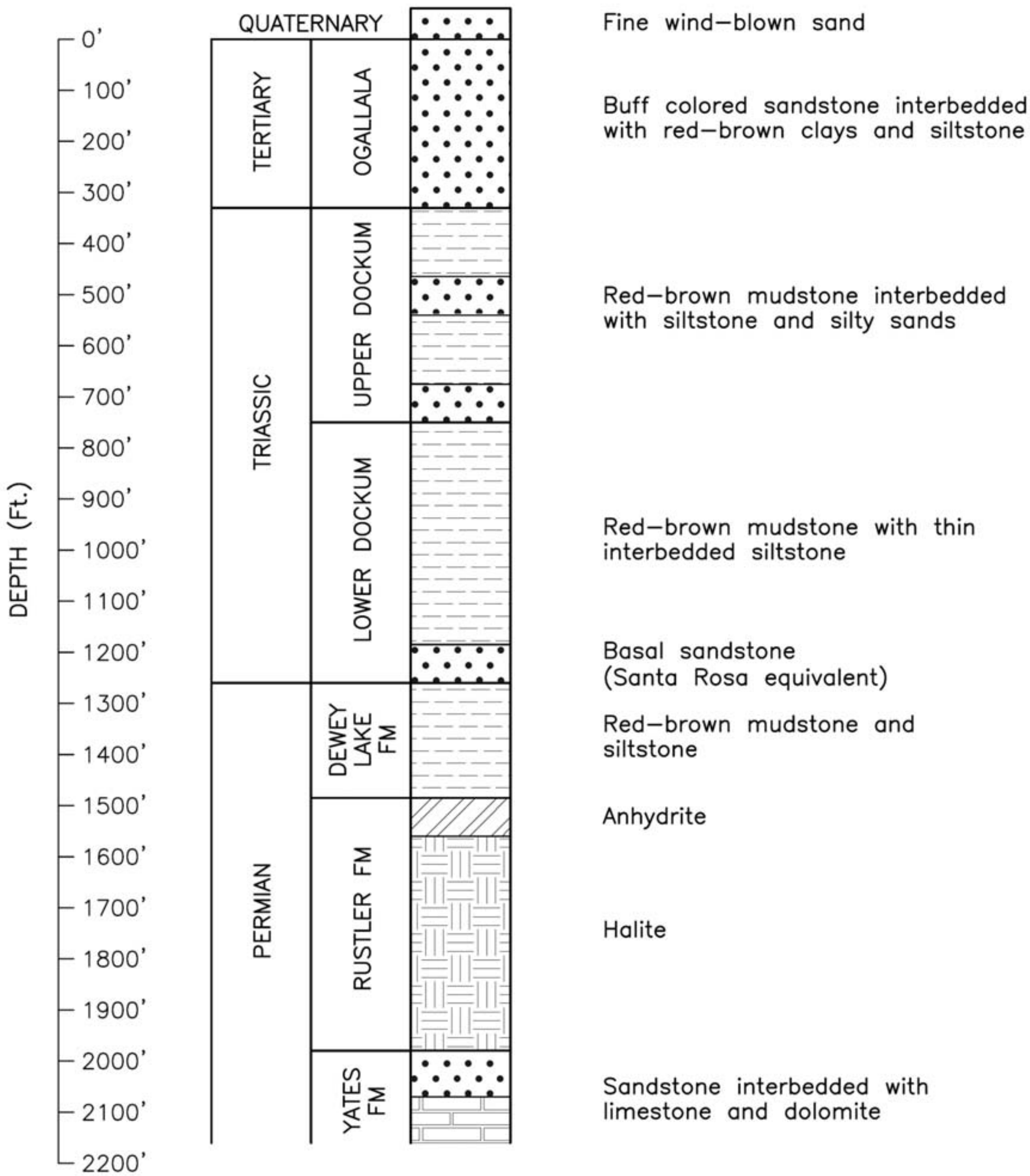


Figure 9-9. Stratigraphic column of sediments at the site area (9-072)

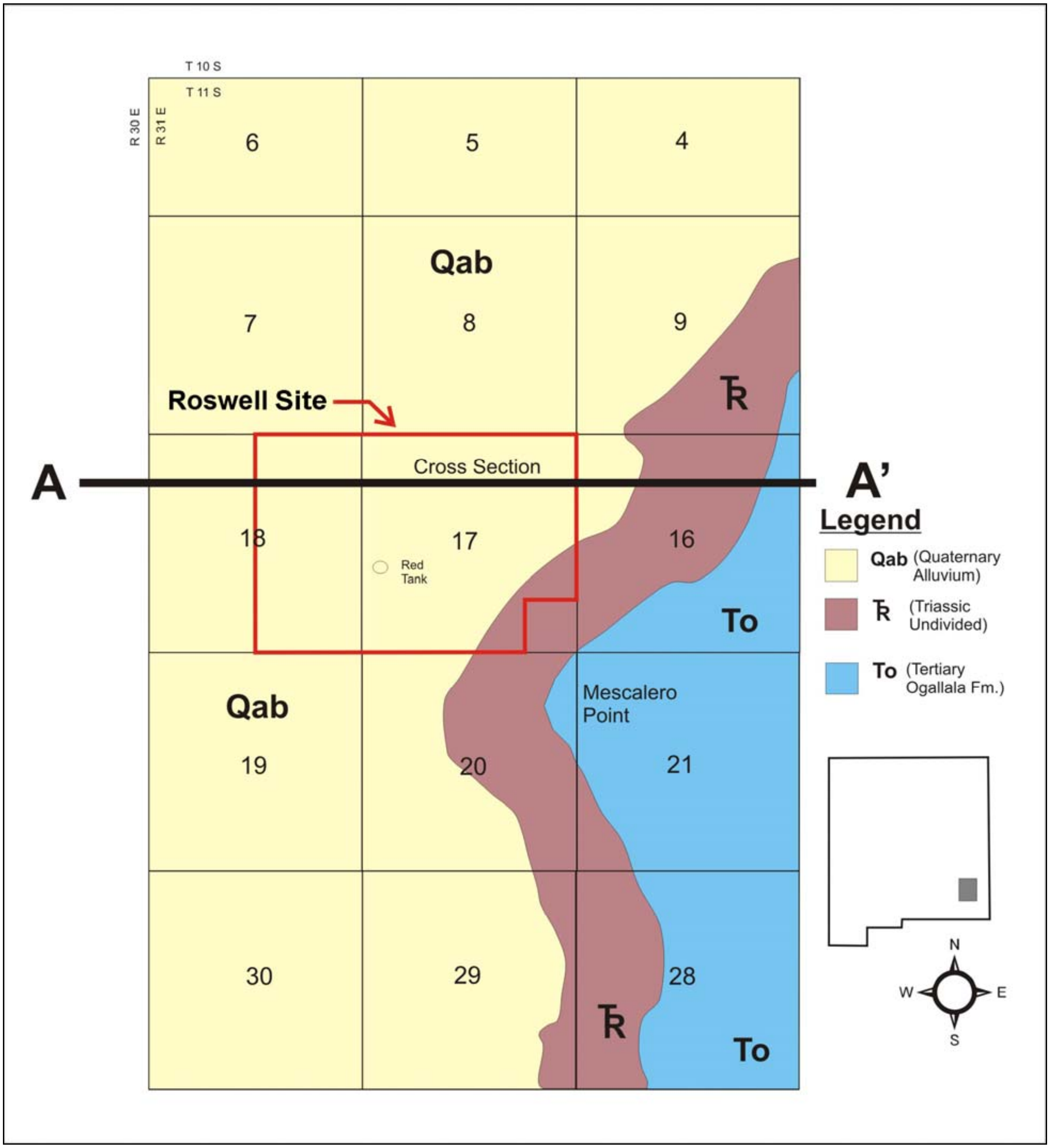


Figure 9-10. Generalized geologic map of the site area (modified from 9-009).

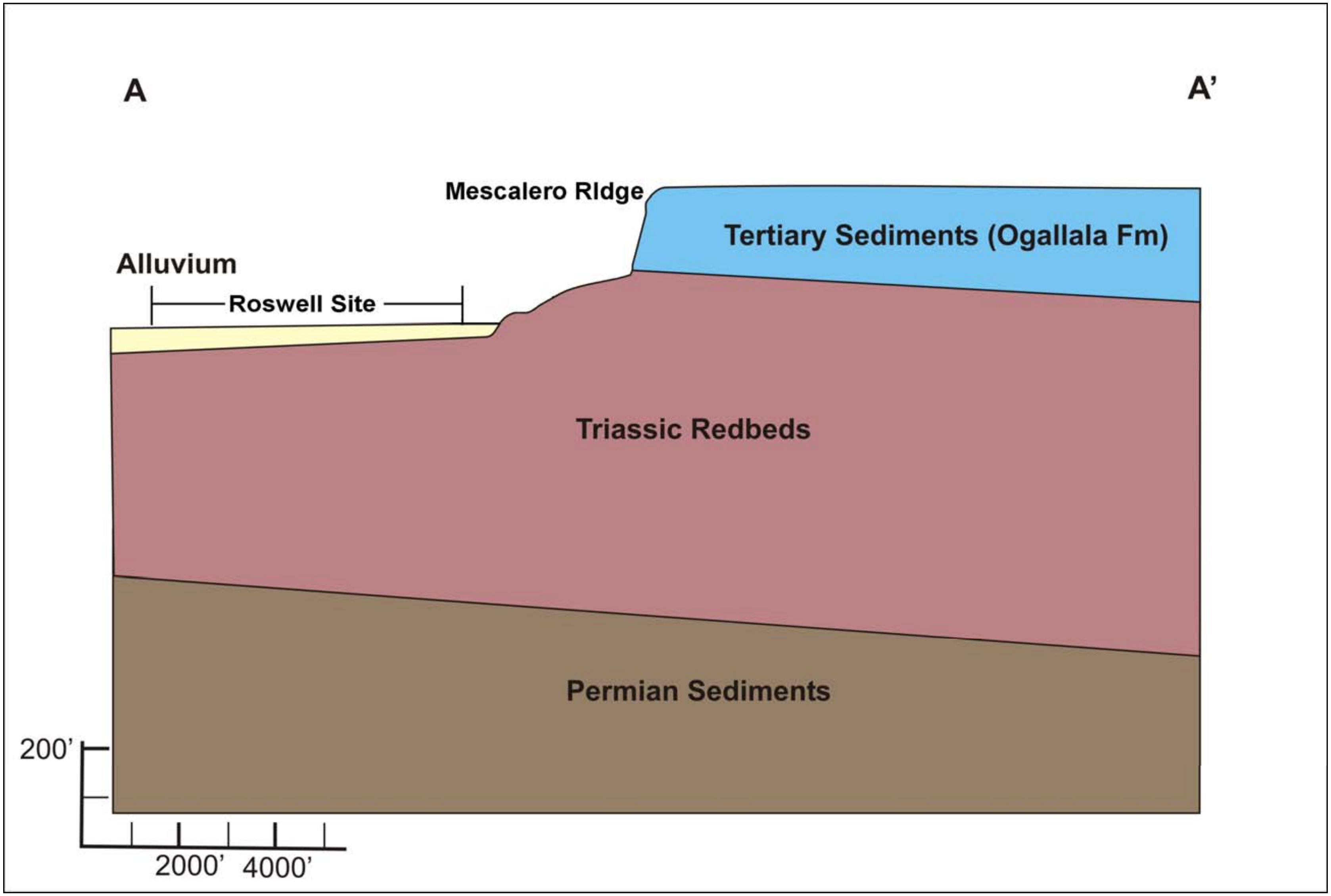


Figure 9-11. East-west cross section of site area (modified from 9-009).

9.2.2.1 Quaternary Deposits

The surface of the site area is covered by a thin layer of primarily eolian sediments (Figure 9-12). The thickness of these deposits in the site area ranges from a few feet to as much as 35 feet. These sediments are composed primarily of fine-grained, red-brown sands, silts, and clays. These sediments are derived primarily from the Tertiary Ogallala Formation, as evidenced by the abundant granitic cobbles, chert pebbles and fragments of petrified wood

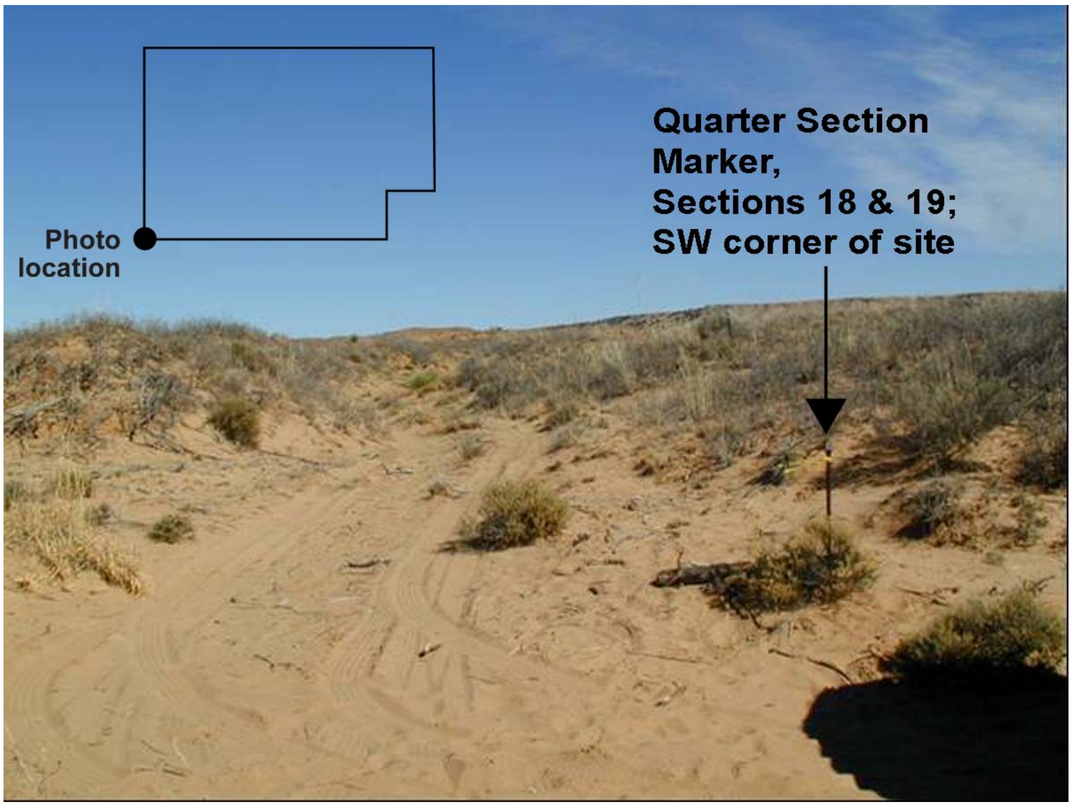


Figure 9-12. Quaternary eolian sediments at the southwestern corner of the Roswell site.

9.2.2.2 Tertiary Sediments

Tertiary sediments do not occur directly within the site boundary. These sediments unconformably overlie the Triassic Dockum Group east of the site, forming the caprock of the Mescalero Ridge escarpment (Figure 9-13 and 9-14). The Tertiary sediments are classified as the Ogallala Formation. This formation was deposited in a fluvial environment and consists of sand, silt, clay, and gravel (9-074). The gravels generally occur in basal conglomerates and primarily consist of quartz, quartzite, sandstone, limestone, chert, igneous rock, and metamorphic rock. There are also abundant petrified wood fragments throughout this unit. The Ogallala Formation is typically capped by a well-defined, and often massive, caliche zone.

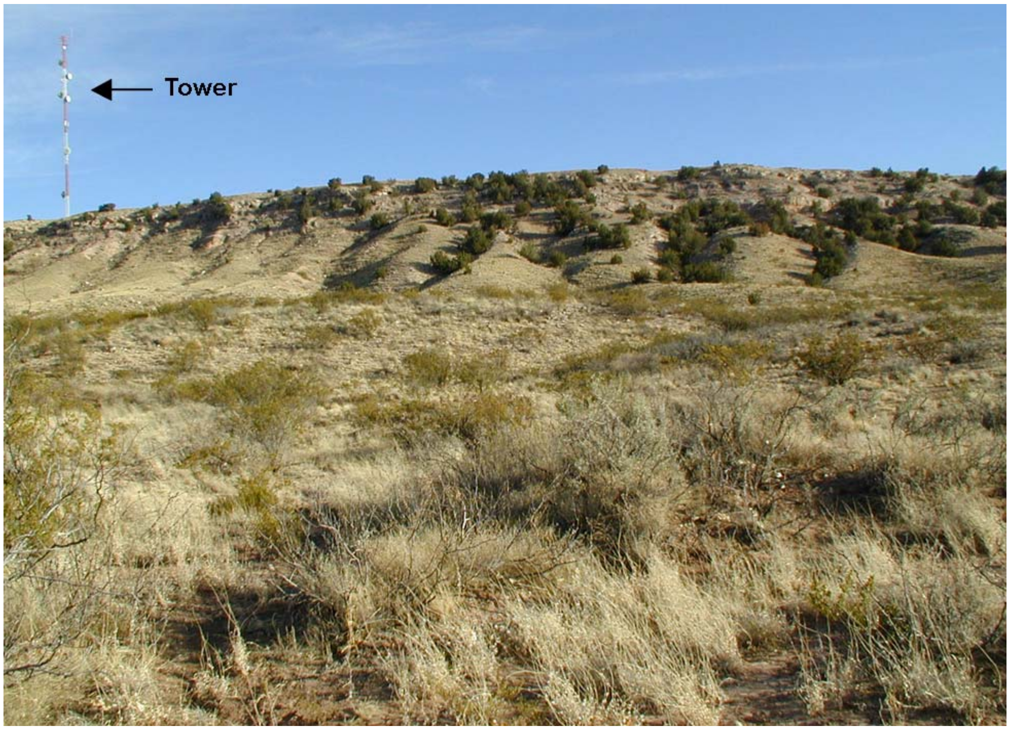


Figure 9-13. Ogallala Formation sediments exposed in the Mescalero Ridge escarpment immediately east of site.

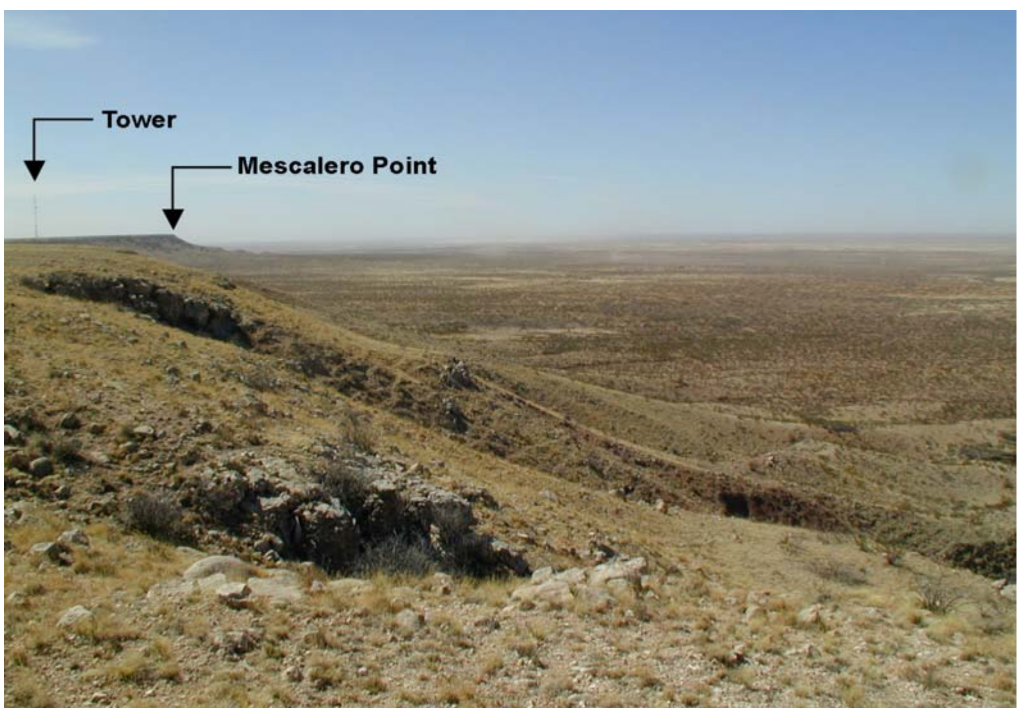


Figure 9-14. View south along the Mescalero Ridge escarpment. Ogallala Formation sediments are to the east (left) of the escarpment, and Dockum Group sediments overlain by Quaternary eolian sediments are to the west (right) of the escarpment. The site is to the west (right) of Mescalero Point.

9.2.2.3 Triassic Sediments

The Triassic sediments underlie the unconsolidated Quaternary deposits at the site. The Triassic sediments in this area are classified as the Dockum Group, the origin and nature of which is detailed by McGowen (9-003). Local investigation of the upper portion of the Dockum Group, including an intensive drilling program, are the primary sources of the following summary (9-007, 9-072).

The Dockum Group unconformably overlies the Permian sediments. Regionally, the Dockum Group is comprised of a wide of sediments including conglomerates, sandstone, siltstone, and mudstone deposits as great as 2,000 feet thick in this part of the Permian Basin. Locally, the Dockum group is comprised of redbed mudstones and interbedded siltstones with a total thickness of approximately 1,200 feet (9-007).

Outcrops of the Dockum Group in the site vicinity are lacking, due to coverage by Quaternary deposits and because the Dockum Group sediments are composed primarily of non-resistant clays and silts. Due to the lack of Dockum Group outcrops at the site, an intensive drilling program was performed to ascertain the nature of the Triassic sediments at the site (9-007). The results indicated that the Dockum Group sediments at the site are comprised of variegated redbed sequences comprised of mudstones and siltstones. A 70-foot thick layer of sandstone, with a coarsening-up texture, is present approximately midway through the section of Dockum Group sediments at the site.

The Dockum Group is generally divided into two formations: the Upper Dockum and the Lower Dockum. At the site, the Upper Dockum (also known as the Chinle Formation) is approximately 475 feet thick and the Lower Dockum is approximately 700 feet thick. The mode of deposition differentiates the Upper and Lower sections of the Dockum Group. The Upper Dockum was deposited in a fluvial system while the Lower Dockum was deposited in a lacustrine system. Hence, lithology is expected to be more spatially variable in the Upper Dockum than in the Lower Dockum.

The Upper Dockum is comprised of a 475-foot thick section of variegated (red-brown-green) mudstones interbedded with reddish gray siltstones and reddish-gray-green sandy siltstones. The siltstones are micaceous, indicating that these sediments were laid down in an active fluvial system capable of transporting sediments a great distance from their source rocks to the west. Montgomery Watson estimates that 30 percent of the Upper Dockum is comprised of low hydraulic conductivity (2.5×10^{-7} centimeters/second [cm/s]) mudstones (9-009). The lithology of the remainder of the unit is evenly divided between siltstones and sandy siltstones, which have virtually indistinguishable hydraulic conductivity (1.2×10^{-5} cm/s).

The Lower Dockum is comprised of a 700-foot section of fairly homogenous reddish-brown mudstones, with occasional thin beds of siltstone. The homogeneous nature of this section contrasts with that of the Upper Dockum with its abrupt facies changes. The sediments are interpreted to have been deposited in relatively low energy lacustrine system. A relatively thin (less than 70 feet) basal sandstone exists at the bottom of the Lower Dockum (9-072). This section of sandstone is interpreted as the local equivalent of the Santa Rosa sandstone, which is a widespread, buff-colored sandstone that was deposited throughout much of the Triassic Basin. The remainder of the Lower Dockum sediments at this site are comprised of fine-grained sediments, as is evidenced in Figure 9-7. This figure documents the distribution of percentages of sand throughout the Triassic Basin. In the site area, the Lower Dockum is comprised of less than 30 percent sand. Analyses of core samples from the Lower Dockum show a very low average hydraulic conductivity of 5.7×10^{-8} cm/s (9-009).

9.2.2.4 Permian Sediments

The Permian sediments underlying the Triassic Dockum Group that are present at the site are assigned to the Artesia Group. The upper portion of the Artesia Group includes the Dewey Lakes Formation, the Rustler Formation, and the Yates Formation. The identification of these formations present at the site is supported by investigations of oil well logs and an east-west cross section of the area (9-001). Based on analysis of the elevation of Permian marker beds (e.g., the top of the Rustler Formation), the strike and dip of the Permian formations are north-south and less than 1 degree to the east, respectively.

The Dewey Lakes Formation is classified as intercalated red-brown mudstones and siltstones (i.e., redbeds). Approximately 240 feet of Permian redbeds are present beneath the site. These Permian redbeds are conformably overlain by the Triassic redbeds, which makes the break between the two differently-aged redbeds difficult to distinguish.

Underlying the Dewey Lakes Formation is the Rustler Formation, which is composed primarily of evaporates. The Rustler Formation is composed of an upper 40-foot thick section of anhydrite capping approximately 500 feet of halite.

The Yates Formation underlies the Dewey Lakes Formation. The Yates Formation is composed of interbedded, light gray, fine to very-fine sandstone with minor dolostone and limestone. The limestone in this section is a white to light gray microcrystalline mudstone with a chalky texture. The dolostone is microcrystalline and ranges from light gray to pink in color.

9.2.3 Structural and Tectonic Features – Local and Regional

As discussed in Section 9.2.1, the site lies on the western flank of the Permian Basin in the Pecos River Valley Section of the Great Plains Physiographic Province. The structure of this site is comprised of roughly 9,000 feet of Permian-Triassic sediments striking roughly north-south with less than 1 degree of dip to the east. The gentle tilt of the pre-Tertiary sediments was associated with the Laramide orogeny, which is no longer active. The region in which the site is located is considered one of the more tectonically stable in the country (9-009). The nearest tectonic center to the site is the Rio Grande Rift (the Sacramento Section of the Basin and Range Physiographic Province), which is located approximately 100 miles west of the site. As indicated in Section 9.3.1.5, there have been no earthquakes of Ma 3 or larger in either the pre-instrumental or instrumental time periods within 50 miles of the site (according to USGS National Earthquake Information Center [NEIC] earthquake catalogs) (9-065).

There are no surface faults within or adjacent to the site. Furthermore, no faults were identified in the underlying Triassic sediments during the most recent drilling study (9-009). The closest Quaternary fault is located approximately 100 miles to the west of the site as indicated by the USGS Quaternary Fault and Fold database (9-044). The occurrence of nearby Quaternary faults and seismic hazards are discussed in detail in Section 9.3. The Mescalero Ridge escarpment to the east of the site is an erosional feature, not a fault.

9.2.4 Occurrence of Groundwater Beneath the Roswell Site

The occurrence of groundwater in the vicinity of the site is described in greater detail in Section 3.1 of this report. In the area of the site, there are two recognized aquifers: the Triassic-age Dockum Group present beneath the site, and the Tertiary-age Ogallala Formation that lies immediately east. The Dockum Group aquifer beneath the site yields little water and of very poor quality. The Ogallala aquifer is a prolific source of groundwater throughout the Great Plains Province. The westernmost extent of the Ogallala Formation is the Mescalero Ridge about 1 mile east of the site; it extends eastward from there.

The Ogallala aquifer is not present beneath the site and is not in direct hydraulic communication with the onsite Triassic Dockum Group aquifer, with the exception that Ogallala groundwater may discharge as springs near Mescalero Ridge or underflow, and recharge shallow groundwater systems west of Mescalero Ridge.

9.2.5 Occurrence of Mineral and Petroleum Resources Beneath the Roswell Site

The primary information source for this section is the *Summary of the Mineral- and Energy-Resource Endowment, BLM Roswell Resource Area, East-Central New Mexico* (9-015), which provides a summary of two comprehensive reports detailing the mineral and energy resource endowment in the Roswell Resource Area, New Mexico. The Roswell Resource Area is located in east-central New Mexico and is comprised of seven counties including Chaves County, in which the site is located. The study was a collaborative effort between the USGS and the U.S. Bureau of Mines (USBM).

The study included a comprehensive list of economic resources including metals (e.g., gold, silver, copper, iron, etc.), industrial minerals (e.g., caliche, clay, aggregate, gypsum, etc.), and energy resources (e.g., oil and gas, coal, uranium, etc.). The study divided the resource area into three provinces: 1) Lincoln County, 2) Northwestern Shelf of Permian Basin, and 3) Tucumcari Basin. The site is in the Northwestern Shelf of the Permian Basin in eastern Chaves County.

A chart provided in the USGS-USBM report summarizes the potential mineral resources in each of the three provinces (9-015). This chart was used as the basis of constructing a simplified chart of potential mineral and energy resources at the site (Table 9-1). Note that this chart is based on the potential mineral resources of the entire Northwestern Shelf of the Permian Basin; it is not based on site-specific studies or prospecting at the site.

Based on the USGS-USBM study, there are several potential resources present at the site. The most accessible resources lie in the Quaternary alluvium and the Tertiary Ogallala Formation. These resources include aggregate, caliche, gravel, and sand. Nearby in the Tertiary Ogallala Formation, potential resources include aggregate, caliche, limestone, and uranium/vanadium deposits (the least likely to occur). There are no potential resources listed in the Triassic Dockum group. The pre-Triassic potential resources are primarily associated with the evaporites and carbonates that were laid down during the Permian. These resources include anhydrite, bromine and iodine (brine), halite and polyhalite, gypsum, potash, and phosphorous. Other potential resources in the pre-Triassic formations include oil and gas, sulfur, and "Pecos Diamonds." Pecos Diamonds are low-temperature replacement quartz crystals found primarily in the Seven Rivers Formation of the Artesia Group.

The Northwestern Shelf of the Permian Basin is most important for its petroleum-related resources. However, the USGS-USBM report points out that "exploration activity in the area is in a mature state, a characteristic typical of the Permian Basin province." The USGS-USBM report goes on to point out that 96 percent of all oil exploration in the area was completed prior to the 1970s. The remaining 4 percent was conducted in the 1970s and 1980s. Similarly, 88 percent of natural gas exploration was carried out prior to the 1980s, with the remaining 12 percent carried out in the 1980s. Note, however, that at the time of the USGS report (1993) oil exploration may have been in decline. The "mature" state of petroleum exploration of 1993 may not be reflected today.

Table 9-1. Chart listing potential mineral resources in the site area (9-015).

ERA	Period	Epoch	Host Sediment/Rock	Economic Resource
Cenozoic	**Quaternary**	Holocene	Alluvium	Ca, Agg, Sd
		Pleistocene		
	Tertiary	Miocene	Ogallala Formation	Ca, Agg, L UV?
		Oligocene		
		Eocene		
		Paleocene		
Mesozoic	**Triassic**		Dockum Group	
Paleozoic	**Permian**	Upper	Dewey Lake Formation	G, L, Br
			Rustler Formation	P, Ph
			Salado Formation	H, P, Ph, An, Su
			Artesia Group	H, P, Ph, An, G, I, Br, Pd, S, PET
		Lower	San Andres Formation	An, H, G, L, Agg, Sd, PET
			Yeso Formation	H,G, PET
			Abo Formation	G, PET
	Pennsylvanian-Silurian		Pre-Permian Formations	PET

Notes:

Agg = Aggregate
An = Anhydrite
Br = Bromine (brine)
Ca = Calcium
G = Gypsum
H = Halite
I = Iodine (brine)
L = Limestone
P= Potash
Pd = "Pecos Diamonds"
PET = Oil and Gas
Ph = Polyhalite
S = Salt
Sd = Sand and Gravel
Su = Sulfur
UV? = Uranium and Vandium potentially present

In summary, there are potential mineral and energy resources present at the site. Most of these resources fall into the industrial mineral category (e.g., caliche, aggregate, etc.). The most accessible are those found in the Quaternary alluvium at the site. According to the USGS-USBM report, there are no potential mineral resources associated with the Triassic Dockum group. While there are numerous potential mineral and energy resources associated with the pre-Triassic sediments present the site, it is unlikely that these resources will be tapped due to their being located at great depths below the surface. These mineral resources are not economically viable for mining. Potential oil and gas reserves present in the subsurface at the site may be explored in the future; but as the USGS-USBM report points out, the exploration of the Permian is in a "mature" state. Therefore, future petroleum exploration is unlikely.

9.3 Seismic Characteristics

This section provides information about the seismic characteristics of the Roswell site (9-031). Detailed information about the seismic characteristics of the site is provided due to its importance in facility siting and design.

Seismic processes that may potentially affect the site include vibratory ground motions from future earthquakes (associated with both nearby and distant sources) and possible fault surface rupture at the site. Future earthquakes can be divided into those emanating from known capable Quaternary faults, and background (random, or “floating”) earthquakes that do not occur on a mapped fault. This section describes the seismic characteristics of the site and its surrounding vicinity. Vibratory ground motion is discussed in Section 9.3.1 and surface faulting is discussed in Section 9.3.2.

The detailed information presented in Sections 9.3.1 and 9.3.2 is summarized below.

- 1,794 earthquakes in New Mexico larger than moment Ma 1.3 in the time period 1962 to 1995 have been cataloged. These earthquakes are not uniformly distributed, but occur in clusters and bands, particularly west and south of the site in the Rio Grande rift. Earthquakes in Texas also occur in clusters in the Rio Grande rift of far western Texas, in a cluster opposite the southeast corner of New Mexico, and in the northern Panhandle. Some of these clusters include seismicity artificially induced by oil and gas production, secondary recovery, or waste injection.

- The site itself is located in an area of relatively sparse seismicity between diffuse zones and clusters of more concentrated (albeit low-magnitude) seismicity. There have been no earthquakes of Ma 3 or larger within 50 miles of the site.

- There are no mapped faults located within 50 miles of the site to the north, east, or south. A large group of faults lies 50 to 100 miles to the west and includes 7 major faults and numerous minor faults. Quaternary faults associated with the Rio Grande rift and active Neogene east-west extension are about 100 miles west of the site. The closest of these faults (Guadalupe fault) lies 94 miles southwest of the site, but is very short, only 3.5 miles long. The closest significant rift-related fault is the 68-mile long Alamogordo fault, which lies as close as 123 miles west of the site. The only other faults to lie within 100 to 150 miles of the site are those in the northern end of a branch of the Rio Grande rift that extends up from El Paso, Texas into southern New Mexico. The closest of these faults lies 118 miles south-southwest of the site. The axis of the Rio Grande rift lies about 150 to 200 miles west of the site. There are nearly 100 Quaternary normal faults between 150 and 200 miles of the site associated with the Rio Grande rift.

- Of the 101 faults within a 200-mile radius, only eight faults exceeded the minimum length specified by Appendix A of 10 CFR 100. Six of these eight were deemed to be capable.

- The predicted ground motion values at the site are relatively low (0.01 to 0.05 g for 10 percent probability of exceedance (PE) in 50 years; 0.04 to 0.12g for 2 percent PE in 50 years). These low values reflect several factors at the site: 1) the low rates of historic earthquake occurrence in the area, 2) the low magnitudes of such earthquakes, and 3) the large distance (generally 150 to 200 miles) to Quaternary faults capable of generating larger earthquakes (Ma > 6.5).

- Most of the ground motion predicted for a 475-year and 2,475-year return periods (10 percent and 2 percent of occurring in a 50 year period, respectively) arises from low-magnitude background earthquakes (earthquakes below the threshold for surface rupture, ca. Ma 6.5) occurring randomly around the site. The locations and magnitudes of these earthquakes are based on the patterns of local historic seismicity.

- Because there are no mapped faults within 5 miles of the site, and the nearest known Quaternary fault is 94 miles away (Guadalupe fault), the probability of surface faulting at the site is negligible.

9.3.1 Vibratory Ground Motion

This section provides information about vibratory ground motion during earthquakes required by 10 CFR 100, Appendix A IV(a).

9.3.1.1 Geologic Setting

The Roswell site is located in southeastern New Mexico in the Great Plains physiographic province, at the boundary between the Pecos Valley (to the west) and High Plains (to the east) sub-provinces (9-033). The site is underlain by sedimentary rocks that have not been significantly deformed by faulting or folding. The nearest significant tectonic feature, the Rio Grande Rift, is located approximately 100 to 200 miles west of the Roswell site.

9.3.1.2 Tectonic Structures

This section provides information about tectonic structures required by 10 CFR 100, Appendix A Section IV(a)(2). The information presented in this section can be summarized as follows.

- Numerous faults associated with the Rio Grande rift are approximately 100 to 200 miles west and south of the site,

- The closest Quaternary fault associated with the Rio Grande Rift is 94 miles southwest of the site, but is very short (3.5 miles),

- The closest significant rift-related fault is 123 miles from the site,

- No faults within 54 miles of the site have been mapped at ground surface, and

- A concealed fault has been identified 34 miles southwest of the site, but there are discrepancies in the descriptions of its length.

The site also lies on the boundary between the Southern Great Plains stress province and the Cordilleran Extension stress province (9-045). At the latitude of the site, both provinces are typified by roughly east-west tensional stress.

According to the Geologic Map of New Mexico (9-030), there are no mapped faults within 50 miles of the site to the north, east, or south. A large group of faults lies 50 to 100 miles to the west of the site and includes seven major faults and numerous minor faults, all of which strike N35-50E (9-016). This fault group is described as follows (9-016):

"*A series of northeast-trending faults and folds, some termed buckles in the literature, occur on the southern Pecos Slope west of Roswell (Merritt, 1920). In general, the buckles are straight, exposed for 55-130 kilometers (35-80 miles), and spaced at 13-32 kilometers (8-20 mile) intervals. Many of the buckles may be right-lateral wrench faults, as evidenced by their great length and small amount of throw, associated drag folding, left-branching folds and short faults, and long left-diagonal folds in the blocks between the buckles (Kelley, 1971). Most plunge northeastward and diagonal to regional dip. These faults are named* [from NW to SE] *the Bonito fault, White Tail fault, Serrano buckle, Border buckle, Sixmile buckle, Y-O buckle, and the K-M buckle; many are related to gas accumulations. Additionally, relatively minor, right-lateral offsets include the Ruidoso, Little Creek, Airstrip, and Champ faults and the Purcella buckle (Kelley, 1971). The Bonito fault is a normal fault.*"

The fault closest to the site is the K-M fault (also called the K-M buckle), which lies 32 miles southwest of the site, but it is not exposed at ground surface (9-016). This structure is shown on the Geologic Map of New Mexico (9-030) as a concealed fault (dotted line) 6.5 miles long trending roughly N50E. An alternative description (9-016) is as follows:

"The K-M fault extends in the subsurface from Artesia to about Lake Arthur, near the southern border of the study area (Kelley, 1971). It is apparently about 48 kilometers (30 miles) in length, with the southeast side downdropped as much as 61 m (200 feet) (Kelley, 1971)."

Therefore, there is a discrepancy between the short fault length (6.5 miles) shown on the Geologic Map of New Mexico, which lies entirely north of Lake Arthur, and the 30-mile length and more southerly location cited by Bartsch-Winkler (9-016).

The age of faulting in this group of faults is unknown, although all faults in the group displace Permian formations, so they must be post-Permian. However, there are no younger bedrock formations in contact with most of the faults. The one exception is Bonito fault (westernmost fault), which is shown on the Geologic Map of New Mexico as displacing the Capitan intrusive of Tertiary age, which indicates that movement on this fault has occurred since the Tertiary Period. None of the Quaternary deposits shown on the state map are displaced by any of the faults. Therefore the issue of whether the faults are merely post-Permian, or perhaps post-Tertiary, is significant but unresolved.

During their preparation of the digitized version of the geologic map of the Roswell Resource Area, LaRock and Moore (9-029) stated:

"*The Bonito Fault in Lincoln County was not extended into the Capitan intrusive as indicated on the New Mexico Highway Geologic Map, and the southwestern extent of the Sixmile Buckle was omitted owing to lack of surface evidence*".

The authors did not explain why they made these changes.

Quaternary faults associated with the Rio Grande rift and active Neogene east-west extension are present approximately 100 miles west of the site. The closest of these faults (Guadalupe fault) lies 94 miles southwest of the site, but is very short (3.5 miles). The closest significant rift-related fault is the 68 mile-long Alamogordo fault, which lies as close as 123 miles west of the site. This major rift-related fault is a down-to-the-west normal fault that trends about N10W. The only other faults within 100 to 150 miles of the site are those in the northern end of a branch of the Rio Grande rift that extends northward from El Paso, Texas into southern New Mexico. The closest of these faults lies 118 miles south-southwest of the site.

The axis of the Rio Grande rift lies in the 150 to 200-mile distance band west of the Roswell site. Within this distance band there are nearly 100 Quaternary normal faults, which are discussed at length in Section 9.3.1.8.

9.3.1.3 Physical Evidence of Subsurface Material Behavior During Prior Earthquakes

This section provides information about the behavior of geologic material at the site during previous earthquakes, which is required by 10 CFR 100, Appendix A Section IV(a)(3). No site-specific evidence of subsurface material failure during previous earthquakes was observed during previous characterization studies at the site. This is consistent with the aseismic character of the site vicinity.

The types of physical evidence that can be interpreted to infer the behavior of subsurface materials during prior earthquakes include faulting or fissuring of the ground surface, slope failures (landslides and rock falls), liquefaction, sand boils, and excessive settlement. No evidence of these geologic / geotechnical failure modes have been documented at the site or in the vicinity, with the exception of mass wasting along Mescalero Ridge, which occurs even in the absence of seismic activity. The lack of physical evidence of material failure near the site in prior earthquakes likely reflects the relatively aseismic character of the site (see Section 9.3.1.5).

No evidence of surface or subsurface seismic disturbance of the regolith has been documented in the vicinity of the site. The Triassic age Dockum Group underlying the site is flat lying and largely undifferentiated. Geologic cross sections (Section 9.2) reveal no evidence of faulting within the Dockum Group beneath the site. No evidence of Quaternary faulting has been observed within 50 miles of the site (see Section 9.3.1.2). Several test pits were excavated during studies related to the Triassic Park HWDF permit application, and a number of soil borings was completed in 1997. No evidence of surface or subsurface disturbance of soil or rock related to seismic activity was mentioned in the site characterization reports (9-008, 9-009).

The nearest surface expression of Quaternary faulting seems to be related to the Guadalupe fault 94 miles southwest of the site, near the base of the Guadalupe Mountains. The fault exhibits a relatively short scarp that extends from approximately 1.9 miles north to 1.2 miles south of the Chaves/Otero County line, 0.62 to 1.2 miles east of Pinon Creek. The fault is short but recently active, forming scarps in unconsolidated Quaternary deposits at the western base of the Guadalupe Mountains (9-038).

9.3.1.4 Engineering Properties of Subsurface Materials and Foundation Conditions

This section provides information about subsurface material properties required by 10 CFR 100, Appendix A Section IV(a)(4), and provides required information regarding foundation conditions required by DE-FG-07-07ID14802, Attachment 1. The information presented in this section can be summarized as follows.

- Surficial soil types at the site have been characterized via a county-wide soil survey and site-specific characterization studies,
- No soils with unusual properties have been identified at the site,
- Surficial soil types range from sand to clay loam (USDA classification), from silty sand (SM) to low plasticity clay (CL) (Unified Soil Classification System [USCS] classification), and A-2, A-4, and A-6 (American Association of State Highway and Transportation Officials [AASHTO] classification),

- Subsurface soils include silty sand (SM), low plasticity clay (CL), and high plasticity clay (CH) (USCS classification),
- A veneer of unconsolidated material typically less than 20 feet thick overlies siltstone / mudstone of the Dockum formation, and
- Lab-measured hydraulic conductivity values for soil and rock core samples from the site range from 1×10^{-4} to 9×10^{-7} cm/s, indicating that these materials have moderate to low matrix conductivity.
- No site-specific measurements of soil shear strength have been made, and therefore bearing capacity cannot be calculated.
- Based on the lack of any information suggesting that site soils have unusual properties and the presence of bedrock at shallow depth, it is unlikely that unusual foundation conditions will be encountered at the site.

Site-specific geotechnical data were collected to assess the suitability of the site for waste disposal during the Triassic Park HWDF permitting process. The geotechnical data were collected for soil classification and to assess water movement and soil compaction. Site-specific data from direct measurements of soil shear strength, such as direct shear tests, triaxial tests, Standard Penetration Tests, or cone penetration tests are not available, and hence the shear strength values needed to calculate soil bearing capacity are not available. None of the existing geotechnical data suggest that soils at the site have unusual characteristics. Soils information collected during a county-wide soil survey and site-specific studies related to the Triassic Park HWDF permit are presented in this section to demonstrate that the soils at the site do not have unusual properties. Hence it is unlikely that unusual foundation conditions will be encountered at the site. Furthermore, bedrock is present at shallow depth at the site, and hence foundation loads could be transferred directly to bedrock if necessary.

Soil Stratigraphy and Classification

Surface soils at the site consist of Alama loam, Faskin-Roswell complex, Ima fine sandy loam, and the Roswell-Jalmar complex. The majority of surface soil at the site consists of the Faskin-Roswell complex, and the Roswell-Jalmar complex (9-069). Figure 9-15 illustrates the distribution of surface soils at the site, and was prepared using data obtained from the NRCS Soil Data Mart (9-070). The following are descriptions of soils at the site (9-069).

- The Alama series consists of deep, well drained soils. These soils formed in alluvium on flood plains that are rarely flooded. Slopes are 0 to 3 percent. In a representative profile the surface layer is brown loam. The subsoil is reddish brown clay loam and silty clay loam. The substratum is stratified reddish brown and light reddish brown sandy clay loam, silty clay loam, and loam. The soil profile is strongly calcareous and moderately alkaline throughout. Permeability is moderately slow, and available water capacity is 11 to 12 inches.
- The Faskin series consists of deep, well drained soils. These soils formed in Aeolian and alluvial sediments on uplands. Slopes are 0 to 3 percent. In a representative profile the surface layer is brown and strong brown fine sand and loamy fine sand. The upper part of the subsoil is yellowish red and red sandy clay loam. The lower part of the subsoil is reddish brown clay loam. The soil profile is noncalcareoous in the upper part and slightly calcareous in the lower part. It is mildly alkaline throughout.

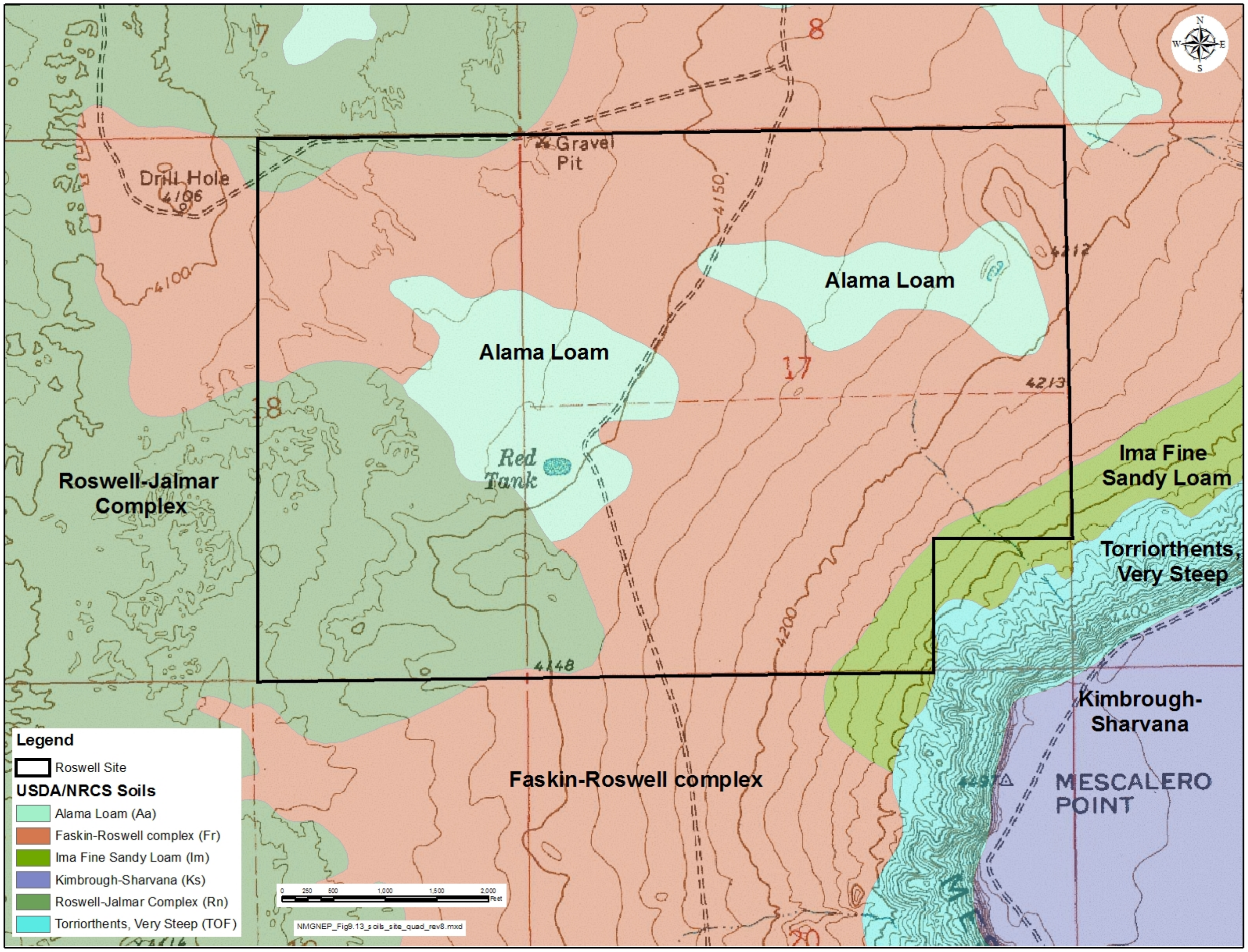


Figure 9-15. Location of soil types in the vicinity of the Roswell site (9-014, 9-056, 9-070).

- The Roswell series consists of deep, excessively drained soils. These soils formed in aeolian and alluvial sediments on uplands. Slopes are 1 to 15 percent. In a representative profile, the surface layer is light brown fine sand. The underlying material is pink fine sand. The soil profile is noncalcareous and pH neutral. Permeability is rapid, and available water capacity is 3 to 4 inches.

- The Jalmar series consists of deep, well drained soils. These soils formed in eolian and alluvial sediments on uplands. Slopes are 0 to 3 percent. In a representative profile the surface layer is brown, reddish-yellow, and yellowish red fine sand and loamy fine sand. The upper part of the subsoil is light reddish brown heavy loamy fine sand. The lower part of the subsoil is light reddish brown sandy clay loam. The substratum is white clay loam that has a high content of lime. It is neutral in the surface layer and becomes mildly alkaline in the lower part of the subsoil and moderately alkaline in the substratum. Permeability is moderate. Available water capacity is 5.5 to 7.5 inches.

- The Ima fine sandy loam is a nearly level to gently sloping soil that occurs on the eastern side of Chaves County on alluvial fans below breaks on the High Plains. Slopes are 1 to 5 percent. Runoff from these soils is medium or slow. The hazard of water erosion is severe with a moderate hazard of soil blowing.

- The Torriorthents, Very Steep, occur along the High Plains escarpment. Slopes are 50 to more than 80 percent. These soils are mainly steep and very steep, calcareous, gravelly, and cobbly. They have medium to coarse texture and commonly are stratified. These soils are mixed with sandstone, red shale, and indurated caliche outcrops. Runoff is very rapid with a severe water erosion hazard. Wind erosion is moderate.

- The Faskin-Roswell complex occurs on severely wind-blown uplands in the eastern part of southern Chaves County. Slopes are 0 to 15 percent. This complex consists of about 50 percent severely eroded Faskin sandy clay loam, 30 percent Roswell loamy fine sand, and 20 percent less extensive soils. Included in the mapping are small, scattered areas of Faskin fine sand or loamy fine sand and Malstrom and Jalmar soils. The Faskin fine sand or loamy fine sand is in areas where soil blowing has not occurred. Jalmar soils are on hummocks less than 4 feet high. The level to nearly level Faskin soil is mostly barren. It has a profile similar to the one described as representative of the series but the surface layer and, in places, part of the subsoil have been removed by soil blowing, exposing the sandy clay loam subsoil. The undulating to rolling Roswell soil is on round to oval hummocks about 5 to 50 feet in diameter and 4 to 8 feet high. The hummocks are partially stabilized by vegetation. This soil has a profile similar to that described as representative for the Roswell series but the surface layer and substratum are loamy fine sand and layers of sandy loam or sandy clay loam occur at depth. Faskin soils runoff is medium with a slight water erosion hazard and a moderate blowing hazard. In Roswell soils runoff is very slow and the water erosion hazard is slight. The blowing soil hazard is severe.

- The Roswell-Jalmar complex occurs on deep sand uplands in the eastern part of Chaves County. Slopes are 0 to 15 percent. The complex consists of about 60 percent Roswell fine sand, 25 percent Jalmar fine sand, and 15 percent less extensive soils. The gently undulating to rolling Roswell soil is in the billowy areas of deep sands. It has the profile that is representative of the Roswell series. The level to nearly level Jalmar soil is in the depressions. It has the profile described as representative of the series. Runoff is very slow. Water erosion hazard is slight but soil blowing is severe.

Table 9-2 lists engineering properties and classifications and Table 9-3 lists physical and chemical properties of surface soil at the site. The suitability of shallow soils at the site for construction of small commercial buildings, local roads and streets, for shallow excavations typically required for underground utilities, and for the potential for corrosion of steel and concrete, was evaluated by the NRCS (9-069, 9-070).

Summary information (Table 9-4) shows that the soil covering most of the site, the Faskin – Roswell Complex has only slight limitations on development. These limitations (cutbank caving and moderate tendency for steel to corrode) can be easily circumvented using readily available conventional technology (e.g. shoring cut slopes and using coatings or cathodic protection to minimize corrosion). The second most abundant soil type at the site, the Roswell – Jalmar Complex occurs in the western portion of the site where sand dunes cover much of the ground surface, and is limited primarily by topographic slope and cutbank caving. The limitation on use due to topographic slope is unlikely to be a substantial impediment to construction of engineered facilities because the steep slopes are associated with sand dunes that generally have less than 10 feet of relief, nor is the low slope stability of these sandy soils an unusual circumstance that would cause severe impediments to facility construction. Together, the area occupied by these two soil types represents over 80 percent of the site area.

Alama Loam is a clayey soil whose suitability for construction of small commercial buildings and local roads is classified as “very limited” due to low strength, high shrink-swell potential, possible ephemeral flooding, and high predicted steel corrosion rate. Alama Loam occupies only about 17 percent of the site area, but occurs in two areas within the central portion of the site that could be inconvenient to avoid during facility layout. If facilities are to be constructed in areas where this soil type is present, then the limitations characteristic of this soil may be circumvented by soil improvement or replacement, by utilizing foundations that transfer loads to more suitable materials at greater depth (e.g. bedrock), or other measures.

The Ima Loam occurs in a narrow band at the extreme southeastern corner of the site, and this soil type occupies only about 3 percent of the site area. The limitations associated with this soil type are only a limitation for shallow excavations and high steel corrosion rate. Given the small area occupied by this soil type and its isolated location area at a corner of the site, the characteristics of this soil type are unlikely to have substantial effects on the suitability of the site for facility construction or operation.

Soils present at 83 percent of the site (Faskin – Roswell complex, Roswell – Jalmar complex, and Ima loam) do not have characteristics that would require unusual construction techniques. The Alama loam that occupies the remaining 17 percent of the site has characteristics that may require additional consideration during facility layout, design, and construction.

No site-specific measurements of soil shear strength have been located, such as standard penetration tests, cone penetrometer tests, direct shear tests, or triaxial testing. Therefore, the site specific shear strength data needed to calculate bearing capacity are not available. Nevertheless, two lines of evidence suggest that soils at the site do not preset unusual foundation conditions. First, the available geotechnical and geologic characterization information do not suggest that any of the samples characterized had unusual properties. Second, soil at the site is a relatively thin veneer over bedrock. The depth to bedrock is typically 10 to 40 feet, based on test pit and borehole logs. Foundation loads could be transferred directly to bedrock instead of soil if subsequent characterization reveals that the soil at the site does not have sufficient bearing capacity to support very large foundation loads.

Soil Physical Properties

Based on test pits installed at the site, surface soils range in thickness from 6 feet to greater than 24 feet (9-010). Test pit locations are shown in Figure 9-16, and a north-south cross section of surface soils encountered during test pits excavation is shown in Figure 9-17. In Test Pits 1, 3, 4, and 5 consolidated material (claystone, mudstone, or siltstone) was encountered at depths ranging from 6 feet to 13 feet below ground surface. Test Pit 2 was excavated to a depth of 24 feet without encountering consolidated rock. The consolidated material is likely the contact between the Quaternary eolian/alluvial surface materials and the consolidated rocks of the Triassic Redbeds of the Upper Dockum Group. No groundwater was encountered in any of the test pits (9-074).

The soil physical properties determined during site investigations related to the Triassic Park permit application summarized below were presented in *Appendices D and E of the Part A and Part B permit Application for the Triassic Park Waste Disposal Facility* (9-073).

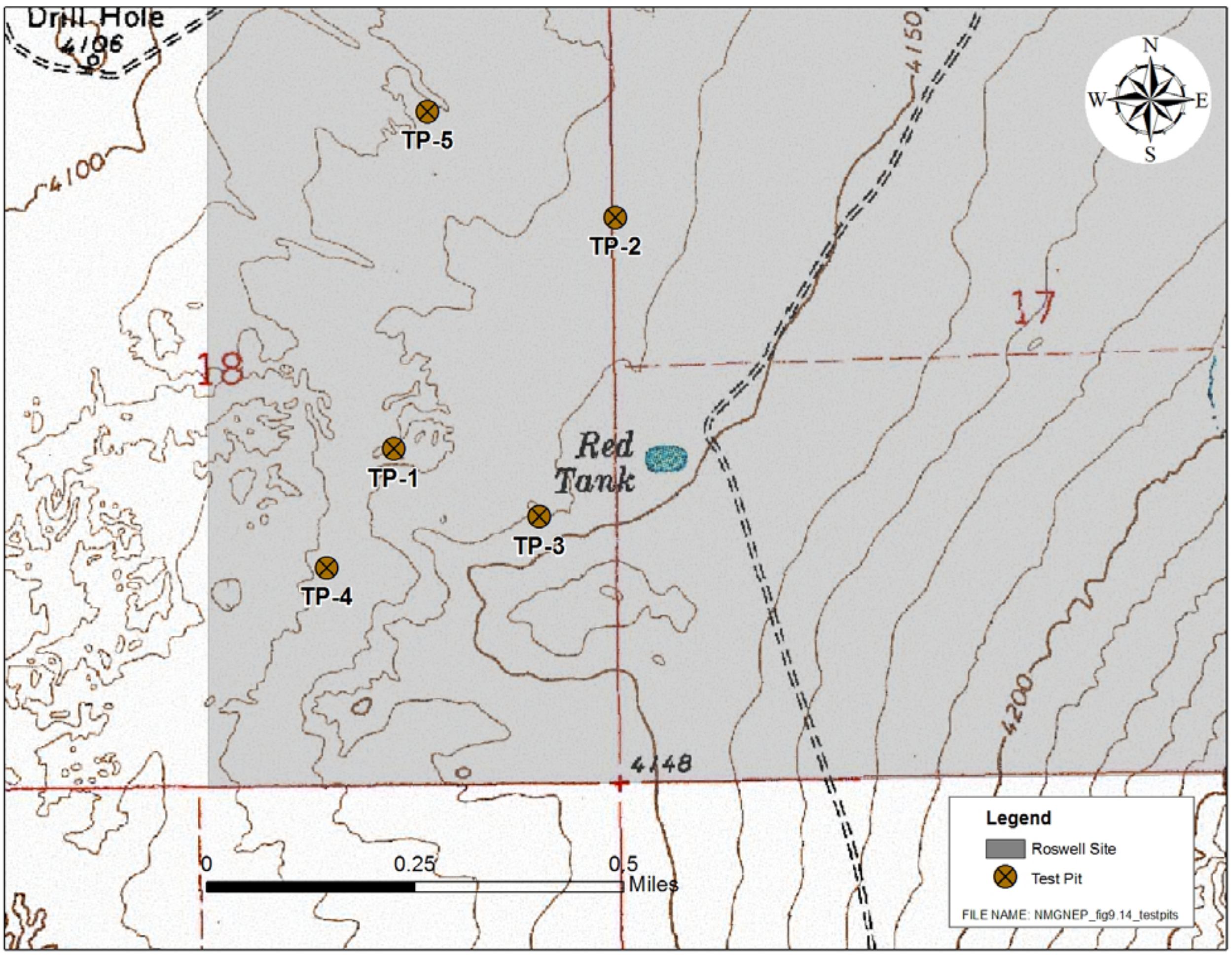


Figure 9-16. Location of test pits excavated during the Triassic Park permit application investigation from the Part A and Part B permit application for the Triassic Park Waste disposal Facility for Volume V Appendices D and E (9-010).

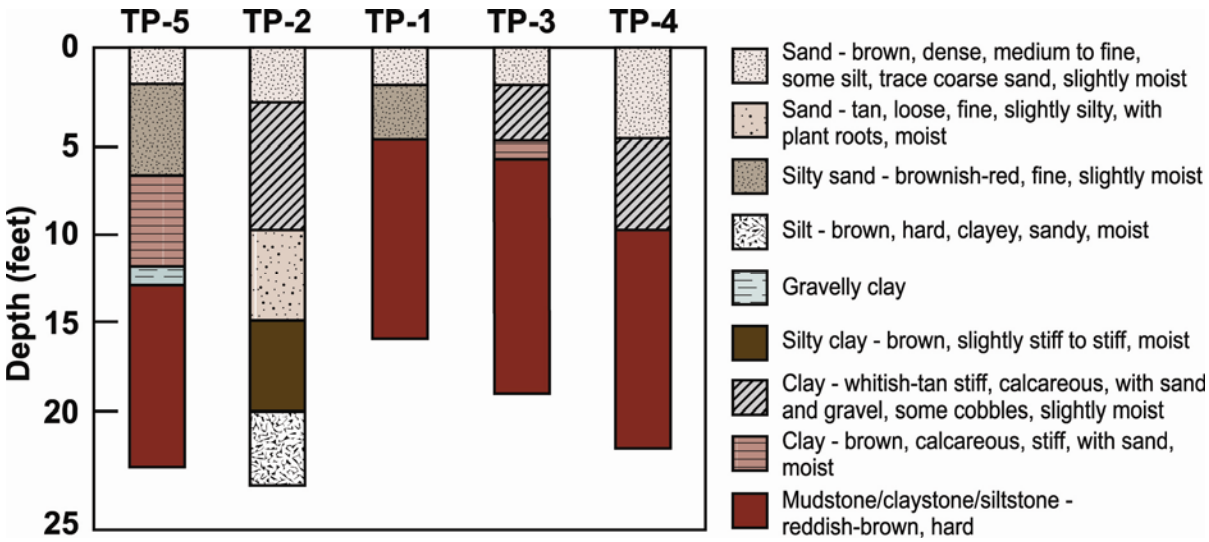


Figure 9-17. North-south soil cross section based on test pits excavated during Triassic Park HWDF permit investigation.

Grain Size

Site surface soil grain size ranges from approximately ¾ inch diameter to clay size. Fines content (material passing the #200 screen) ranges from 18 to 68 percent. Table 9-5 lists grain size distribution for bulk surface soils at the site, the USCS soil classifications, the natural moisture contents, and the Atterberg Limits (Liquid Limit and Plasticity Index) for soil samples collected from the site (9-010).

Analyses of undisturbed subsurface samples (cores) collected at the site indicate that the shallow subsurface (to depths of 30 to 40 feet) consists of mainly of siltstone and mudstone. Fines content (material passing the #200 sieve) ranged from 32 to 99 percent. Physical properties of the subsurface materials are listed in Table 9-6. Borehole locations are shown in Figure 9-18 (9-072).

Density

Subsurface soil and rock densities ranged from 89.3 to 133.8 pounds per cubic foot (PCF) to 133.8 PCF. Specific gravity values are listed in Table 9-6. Surface soil maximum densities (Standard Procter density values) are listed in Table 9-7.

Water Content

Moisture content for site surface soil ranged from 4.0 to 9.6 percent and for subsurface soil and rock ranged from 5.9 to 20.8 percent. Moisture contents are listed in Tables 9-5 and 9-6.

Void Ratio

Void ratios for subsurface soil and rock samples ranged from 0.378 to 0.594. Void ratios are listed in Table 9-8.

Liquid and Plastic Limits (Atterberg limits)

For surface soil samples from the site Liquid Limits ranged from no value to 36 percent and Plasticity Indices ranged from non-plastic to 21 percent. Atterberg limits are listed in Tables 9-5 and 9-6.

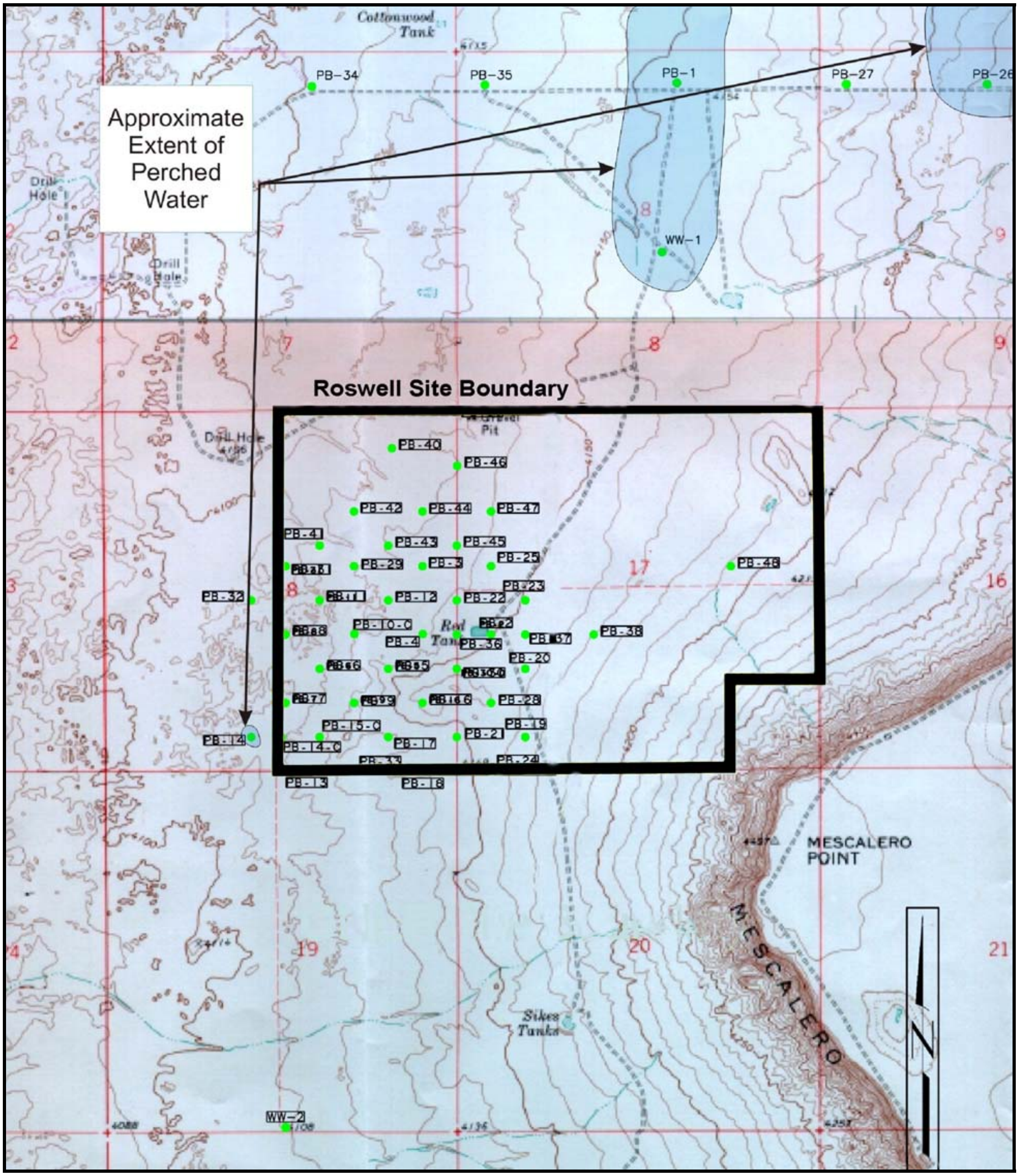


Figure 9-18. Location of soil borings installed at the site (9-072)

Soil Engineering Properties

This section provides information on geotechnical laboratory tests performed on soil samples collected from the site during the Triassic Park HWDF investigations.

Compaction

Standard Procter testing was performed on 15 samples collected from the site. Maximum densities obtained ranged from 110.6 PCF with optimum moisture content at 14.9 percent to 122.6 PCF with optimum moisture content at 10.4 percent (Table 9-7) (9-071).

Hydraulic Conductivity

Laboratory hydraulic conductivity tests were conducted on undisturbed samples collected from the site. Hydraulic conductivity values ranged from 9.2E-7 to 1.5E-4 cm/sec. Permeability test results are listed in Table 9-8.

Consolidation-Swell

Shrink-swell for the types of soils at the site range from very low to medium (9-071). Shrink-swell characteristics for each type of soil are listed in Table 9-3.

Shear Strength

No shear strength test data were located for soils at the site.

Stress-Strain Modulus (Modulus of Elasticity) and Poisson's Ratio

No references regarding site-specific modulus of elasticity or Poisson's ratio data were located for the site. However, the Civil Engineering Handbook (9-050) provides typical values for a range of soil types. Silty sands are listed as having a range of Modulus of Elasticity of 69 to170 megapascal (mPa) and range of Poisson's Ratio of 0.20 to 0.40.

The organic content of subsurface soil at the site is very low, ranging from 0.53 to 1.74 percent (9-071). Organic content test results are listed in Table 9-9.

Table 9-2. Engineering properties and classifications for the surface soils that occur at the Roswell site (9-069, 9-070).

Soil Name and Map Symbol	Depth (inches)	USDA Texture	Classification		LL	PI	Percentage Passing Sieve Number			
			USCS Class	AASHTO			200	40	10	4
Alama Aa	0-3	Loam	ML, CL-ML	A-4	20-30	NP-10	70-80	95-100	100	100
Faskin Roswell Complex Fr	3-58	Silty clay loam, clay loam, silt loam	CL	A-6	30-40	10-15	75-95	95-100	100	100
	58-69	Silt loam, loam, clay loam	CL-ML, CL	A-4, A-6	20-30	5-15	75-90	85-100	100	100
Faskin Roswell complex (Fr) (Faskin part)	0-8	Sandy clay loam	SC, SM-SC, CL	A-4, A-6	20-35	5-15	35-55	65-85	100	100
	8-60	Sandy clay loam, clay loam	SC, SM-SC, CL, CL-ML	A-4, A-6	20-40	5-20	35-70	85-100	100	100
Roswell part	0-88	Loamy fine sand	SM	A-2	NV	NP	15-30	70-95	95-100	100
IMA (Im)	0-8	Fine sandy loam	SM	A-2, A-4	<30	NP-5	25-50	75-100	85-100	90-100
	8-60	Fine sandy loam, sandy loam	SM	A-2, A-4	<30	NP-5	25-50	75-100	85-100	90-100
Roswell Jalmar complex (Rn) Roswell part	0-88	Fine sand	SM	A-2	NV	NP	10-30	70-95	95-100	100
Jalmar part	0-32	Fine sand	SM, SP-SM	A-2	NV	NP	5-25	95-100	95-100	100
	32-64	Sandy clay loam	SC	A-2, A-6	20-35	10-20	25-45	95-100	95-100	100
Torriorthents, very steep (TOF	0-60	Variable	---	---	---	---	---	---	---	---

Table 9-3. General physical and chemical properties for the types of surface soils occurring at the Roswell site (9-069, 9-070).

Soil Name and Map Symbol	Depth (inches)	Permeability (inches per hour)	Available Water Capacity (inches per inch)	Soil Reaction (pH)	Salinity (mmhos/cm at 25°C	Shrink-swell potential	Risk of Corrosion	
							Uncoated Steel	Concrete
Alama Aa	0-3	0.6-2.0	0.16-0.21	7.4-8.4	<2	Low	Moderate	Low
Faskin Roswell Complex Fr	3-58	0.2-0.6	0.16-0.21	7.4-8.4	<2	Moderate	Moderate	Low
	58-69	0.2-2.0	0.16-0.21	7.4-8.4	<2	Moderate	High	Low
Faskin Roswell complex (Fr) (Faskin part)	0-8	0.6-2.0	0.14-0.16	7.4-7.8	<2	Low	Low	Low
	8-60	0.6-2.0	0.12-0.18	7.4-8.4	<2	Low	Moderate	Low
Roswell part	0-88	6.0-20	0.05-0.07	6.6-7.3	<2	Low	Low	Low
IMA (Im)	0-8	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low	Moderate	Low
	8-60	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low	Moderate	Low
Roswell Jalmar complex (Rn) Roswell part	0-88	6.0-20	0.05-0.07	6.6-7.3	<2	Low	Low	Low
Jalmar part	0-32	6.0-20	0.06-0.08	6.6-7.8	<2	Very low	Low	Low
	32-64	0.2-2.0	0.12-0.18	6.6-8.4	<2	Low	Moderate	Low
Torriorthents, very steep (TOF	0-60	---	---	---	---	---	---	---

Table 9-4. Suitability of site soils for various applications (9-069, 9-070).

Use		Soil Type: Faskin-Roswell Complex	Roswell-Jalmar Complex	Alama Loam	Ima
Small Commercial Buildings	Suitability for Use	Not limited	Very limited: slope	Very limited: flooding, shrink swell	Not limited
Roads and Local Streets		Not limited	Somewhat limited: slope	Very limited: Low strength, shrink swell, flooding	Not limited
Shallow Excavations		Somewhat limited: cutbanks cave	Very limited: cutbanks cave	Somewhat limited: cutbanks cave	Somewhat limited: cutbanks cave
Steel Corrosion		Moderate	Moderate	High	High
Concrete Corrosion		Low	Low	Low	Low
USCS Classification		SM, SC-SM	SC, SM, SC-SM,	CL	SM, SC, SC-SM, CL-ML,
Area (%)		59.8	20.7	16.7	2.7

Legend:

- (light green) = No significant limitation
- (yellow) = Intermediate limitations
- (orange) = Substantial limitations

Table 9-5. Sieve analyses results and soil classification for bulk surface soil samples collected at the Gandy Marley site (9-071).

Location	USCS Class	LL (%)	PI (%)	Sieve Analysis Percent Passing Sieve Size										Moisture (%)
				#200	#100	#40	#10	#4	3/8”	1/2”	3/4”	1”	1-1/2”	
PB-2	SC	36	21	41	61	98	99	100						7.6
PB-4	SM	NV	NP	27	34	96	97	99	100					7.5
PB-6	CL-ML	24	6	76	84	89	93	97	99	100				6.6
PB-7	CL-ML	28	6	61	75	98	100	100						9.6
PB-8	SC	28	9	48	65	96	98	99	100					6.4
PB-9	SM	NV	NP	38	76	92	95	96	96	97	97	97	100	5.5
PB-10	CL	30	13	56	80	95	99	100	99					6..5
PB-11	CL	32	12	50	86	94	97	98	99	99	100			5.5
PB-13	SM	NV	NP	21	36	75	99	100						4.4
PB-14	SM	NV	NP	18	24	98	99	99	99	99	100			8.7
PB-15	CL	32	9	56	77	90	98	100						6.6
PB-21	SM	24	3	21	33	64	75	84	93	95	98	100		4.0
PB-30	SC-SM	28	6	21	36	99	100							5.3
PB-31	SM	NV	NP	21	31	97	99	99	100					5.4
PB-33	CL-ML	24	4	68	77	91	96	97	99	100				7.5

Table 9-6. Sieve analysis results for undisturbed subsurface samples (cores) collected at the Roswell site (9-071).

Location	Depth (feet)	USCS Class	LL (%)	PI (%)	Percent Passing #200 Sieve	Dry Density (PCF)	Porosity (%)	Specific Gravity	Moisture (%)
PB-10	14-15	CL	37	14	91	121.7	27.1	2.676	7.5
PB-10	19-20	CL	32	9	80	129.5	22.0	2.660	7.4
PB-10	28-29	SM	29	4	32	130.9	20.5	2.640	5.9
PB-10	38-39	SM	31	8	48	133.8	19.5	2.663	6.9
PB-15	14-15	CL	29	8	87	106.0	37.0	2.696	7.1
PB-15	19-20	CL	35	12	86	109.4	34.9	2.692	7.5
PB-30	14-15	CH	60	19	99	100.4	39.4	2.656	20.8
PB-30	19-20	CL	47	17	98	89.3	46.8	2.690	6.6

Table 9-7. Results of Standard Procter Testing on surface soil samples (9-071).

Location	Maximum Density (PCF)	Optimum Moisture (%)
PB-2	116.6	12.6
PB-4	112.4	14.1
PB-6	122.1	12.8
PB-7	112.6	13.7
PB-8	117.2	13.6
PB-9	114.7	12.2
PB-10	113.6	16.7
PB-11	119.9	12.9
PB-13	116.7	12.2
PB-14	110.6	14.9
PB-15	116.9	15.5
PB-21	122.6	10.4
PB-30	112.5	14.9
PB-31	117.2	12.4
PB33	117.8	12.5

Table 9-8. Summary of subsurface rock and soil laboratory hydraulic conductivity test results (9-071).

Location	Depth (ft)	Lithology	Confining Pressure (PSI)	Initial Moisture Content (%)	Initial Dry Density (PCF)	Initial Void Ratio	Final Moisture Content (%)	Final Dry Density (pounds per cubic foot)	Hydraulic Conductivity (centimeters per second)
PB-10	23.4-23.7	Siltstone	5.0	7.2	120	0.431	16.6	118	7.1E-05
			25.0				14.8	122	9.1E-07
PB-10	29.5-29.8	Sandy Silt	5.0	11.1	123	0.378	17.6	115	9.1E-07
			25.0				12.6	126	5.8E-06
PB-15	11.5-14	Mudstone	5.0	5.6	143.2	N/A	9.9	143.3	2.0E-07
PB-15	26.5-29.0	Siltstone/sandy silt	4.9	7.7	129.8	N/A	15.2	128.4	8.7E-07
PB-30	19.9-20.2	Mudstone	5.0	6.4	117	0.470	14.3	124	3.9E-07
			25.0				12.7	128	1.9E-07
PB-30	30.9-31.1	Sandy Silt	5.0	5.6	118	0.425	12.2	127	8.8E-06
			25.0				12.1	127	3.1E-06
PB-30	37.3-37.6	Siltstone	5.0	13.2	105	0.594	17.2	114	1.5E-04
			25.0				17.3	114	1.3E-04
PB-30	40.5-40.8	CL	5.0	9.9	121	0.425	16.6	118	3.1E-6
			25.0				15.4	121	9.2E-07

Table 9-9. Organic content in subsurface soils from the site (9-071).

Boring Number	Depth (feet)	Lithology	Organic Content (%)
PB-10	21.5-24	Siltstone	1.14
PB-10	29-31.5	Sandy Silt	0.53
PB-30	19-21.5	Mudstone	1.74
PB-30	29.5-31	Sandy Silt	0.77
PB-30	36.5-39	Siltstone	1.27
PB-30	39-41.5	Siltstone	0.76

9.3.1.5 Listing of Historical Earthquakes

This section provides information about historical earthquakes required by 10 CFR 100, Appendix A Section IV(a)(5).

The information presented in this section can be summarized as follows.

- Information about historical earthquakes within 200 miles of the site is readily available,
- Historical earthquakes within 200 miles of the site were primarily small to moderate size,
- However, the largest earthquakes in both New Mexico and Texas occurred within 150 to 200 miles of the site
- Earthquakes in the region tend to occur in clusters and bands, particularly west and south in the Rio Grande Rift, which lies about 100 to 200 miles from the site,
- Five significant earthquakes have occurred within about 200 miles of the site:
  - 1906 – a swarm of 42 earthquakes near Socorro, New Mexico (187 miles northwest of site), including the largest historical earthquake in New Mexico,
  - 1925 – a cluster of earthquakes in the Texas panhandle (~200 miles northeast of the site),
  - 1931 – an earthquake near Valentine, Texas (~200 miles south of the site) was the largest known earthquake in Texas,
  - 1992 – an earthquake in Rattlesnaek Canyon, Texas, (83 miles southeast of the site) is the closest significant earthquake to the site, and
  - 1995 – the earthquake near Alpine, Texas (~200 miles south of the site) is the second largest known earthquake in Texas. Although it occurred in an area occupied by extensional normal faults associated with the Rio Grande Rift, it did not occur at a mapped fault, and
- Some seismic events are associated with injection or extraction of fluids for oil and gas production.

Information on historical earthquakes within 200 miles of the site was obtained from two sources:

- The New Mexico Bureau of Mines and Mineral Resources (NMBMMR) in Socorro, New Mexico, has compiled catalogs of 1962 to 1998 earthquake epicenters (9-038). These catalogs cover the State of New Mexico, as well as "bordering areas," which fortunately for this study, extend into west Texas.
- Earthquake data for the entire U.S. is available from several catalogs maintained by the USGS NEIC (9-067). For this study, three NEIC earthquake catalogs were searched for earthquakes within a circular area with a 200-mile radius centered at the site (Latitude 33.3645°N, Longitude -103.8486°W).

The results of these searches were archived by McCalpin (9-048).

The historical earthquake record for west Texas and southeastern New Mexico can be divided into a pre-instrumental period prior to about 1962, with epicentral locations and magnitudes based largely upon felt reports, and an instrumental period when seismographic coverage of the site region was initiated (9-036). Seismographic coverage of the site region came into existence in about 1962 when the Worldwide Standardized Seismographic Network (WSSN) was installed.

Historical earthquakes within 200 miles of the site are primarily small to moderate-sized earthquakes ranging from Ma (unspecified magnitude scale) 4.0 to 6.4 (Figure 9-19). Although most earthquakes in this radius were small, the largest earthquake in New Mexico history (1906 Soccoro events, moment magnitude [MM] intensity VIII) and the largest earthquake in Texas history, an Ma 6.4 event occurred on August 16, 1931 near Valentine, Texas both occurred within 200 miles of the site. Both of these events occurred before installation of the WSSN seismograph network.

According to the NMBMMR database (9-038), there have been 1,794 earthquakes in New Mexico larger than moment Ma 1.3, in the time period 1962 to 1995 (Figure 9-19). An additional 206 earthquakes occurred in the same period in the bordering areas of the adjacent states (a band up to 50 to 100 miles wide into those states). These earthquakes are not uniformly distributed, but tend to occur in clusters and bands, particularly west and south of the site in the Rio Grande rift. Likewise, earthquakes in Texas are clustered (Figure 9-20), occurring in the Rio Grande rift of far west Texas, in a cluster opposite the southeast corner of New Mexico, and in the northern Panhandle. Some of these clusters include seismicity artificially induced by oil and gas production, secondary recovery, or waste injection (9-038). This topic is discussed in more detail in the *Induced Seismicity* portion of this section. Data for the 2000 events plotted on Figure 9-19 are documented in McCalpin (9-048).

The site lies in an area of relatively sparse seismicity that lies between diffuse zones and clusters of more concentrated (albeit low-magnitude) seismicity (Figure 9-21). For example, according to the USGS-NEIC earthquake catalogs (described later), there have been no earthquakes of Ma 3 or larger in either the pre-instrumental or instrumental time periods within 50 miles of the site.

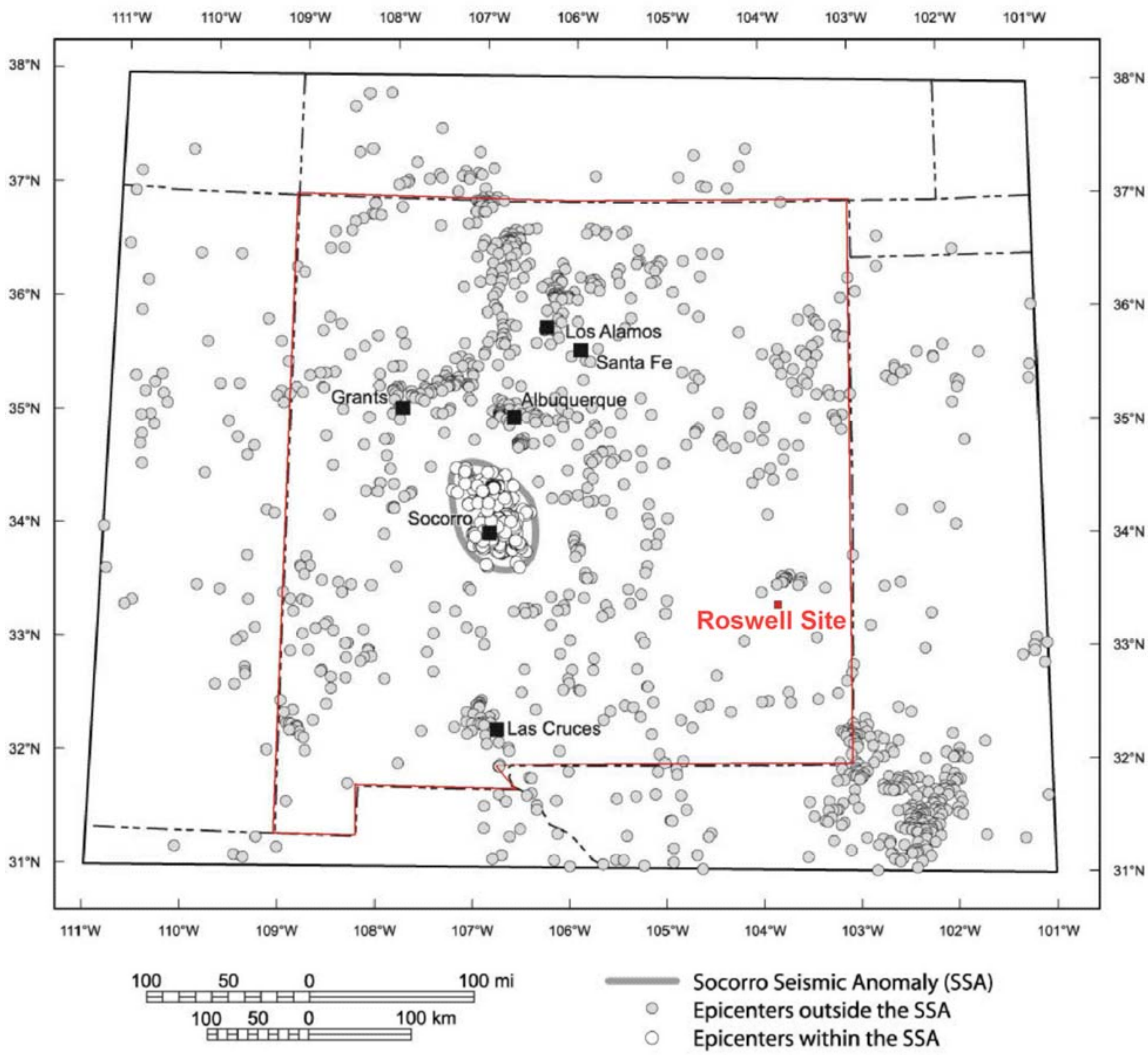


Figure 9-19. Seismicity of New Mexico and bordering areas, latitude 31° to 38° N, longitude 101° to 111°W, 1962 to 1995, MM 1.3 or greater (9-038).

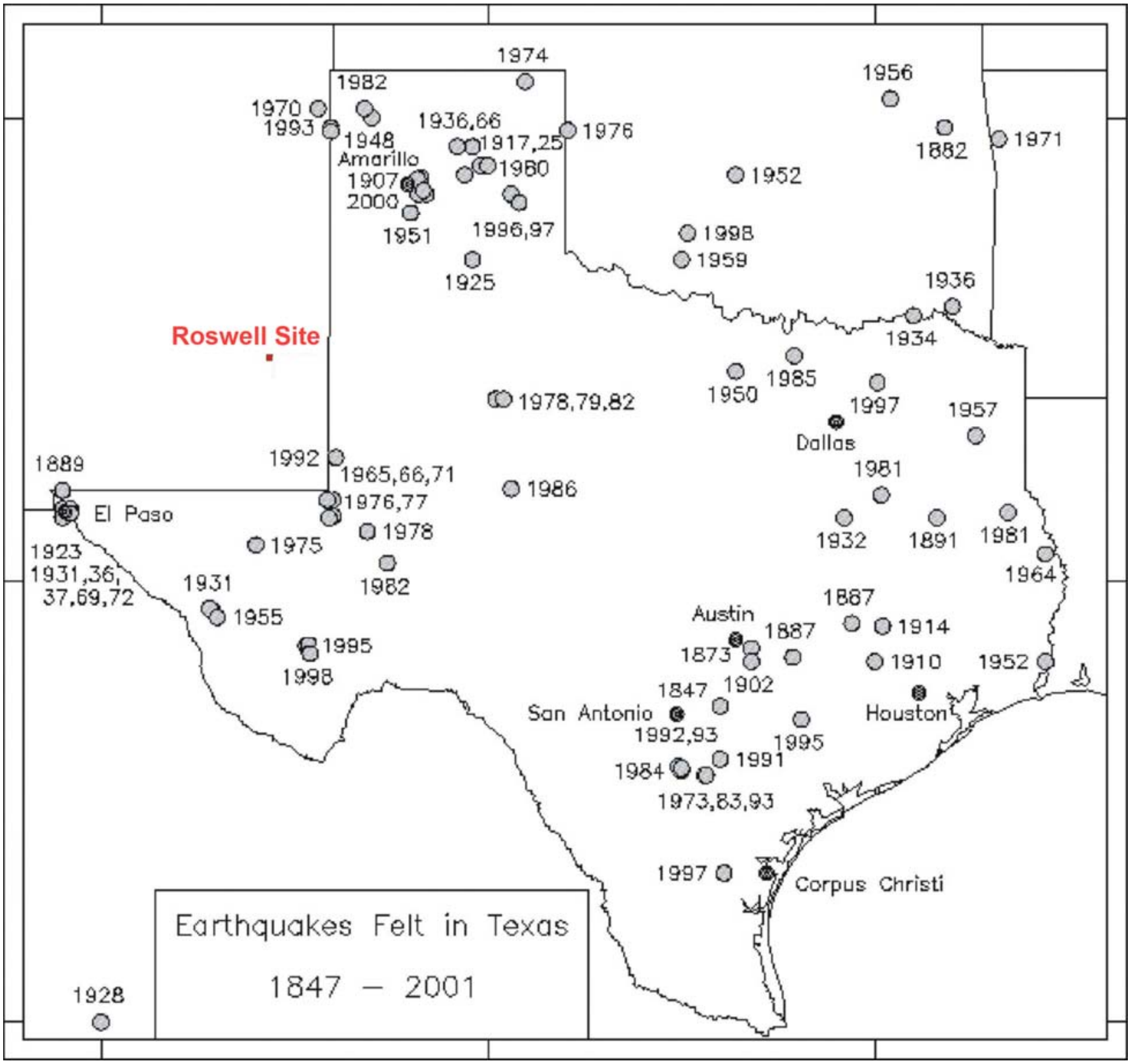


Figure 9-20. Seismicity of Texas, showing the locations and dates of earthquakes and earthquake sequences that occurred in or were felt in Texas (9-040).

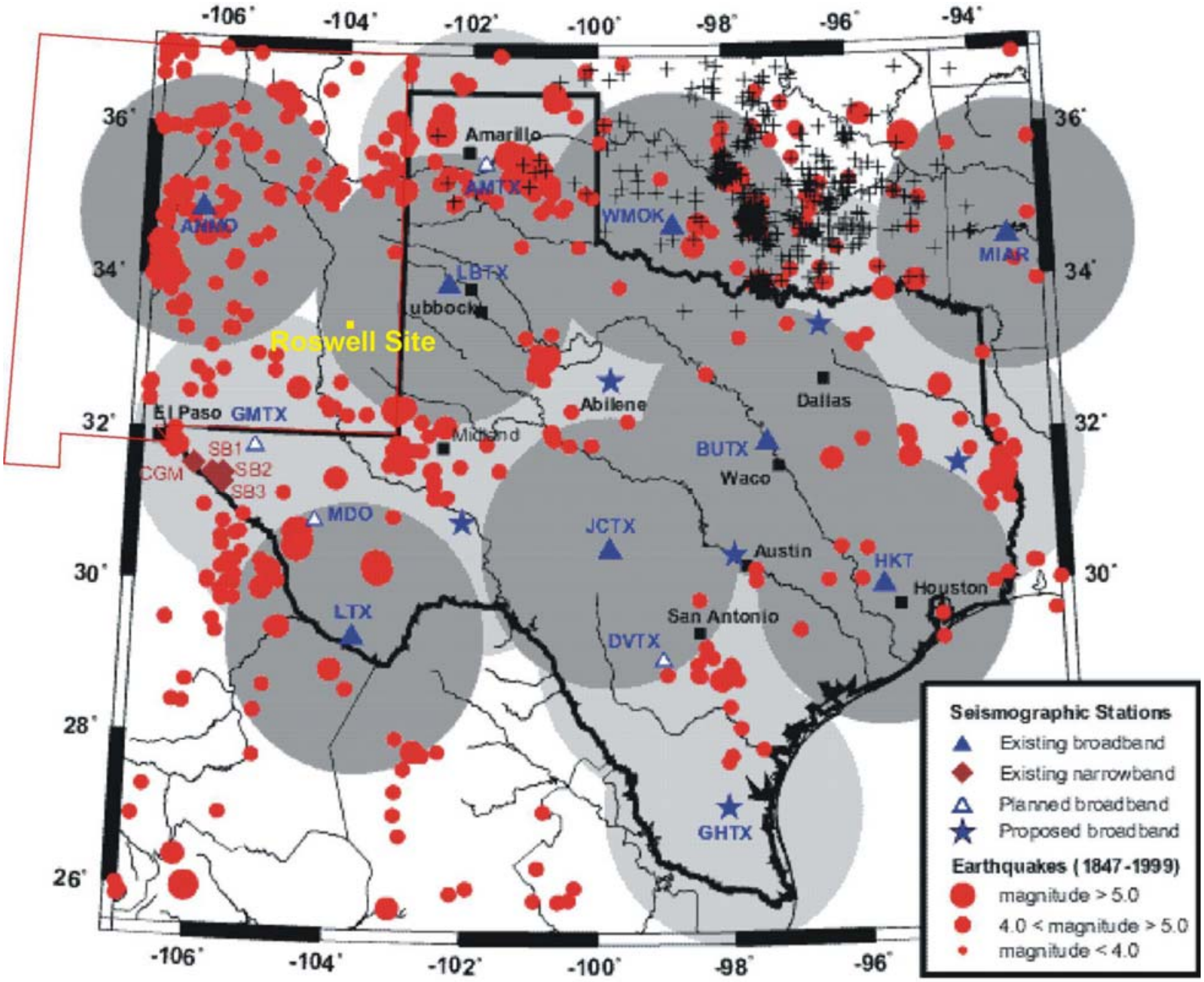


Figure 9-21. Seismicity of New Mexico and Texas. Nominal monitoring capability for Ma 3.5 events for existing seismograph stations (dark shading) and for proposed seismograph stations (light shading) in Texas. Plus signs (+) represent earthquakes detected by the University of Oklahoma seismic network, mostly of Ma < 2.5 (9-040).

9.3.1.6 Significant Historical Earthquakes (Ma > 5) Within 200 Miles of the Site

Five significant earthquakes (Ma ≥ 5.0) have occurred within approximately 200 miles of the site in west Texas and southeastern New Mexico, including the largest historic earthquakes in both of those states. Most of those earthquakes occurred more than 150 miles from the site (Figures 9-22 and 9-23).

#1-- 1906 Socorro, New Mexico (MM VII)

Between July and November, 1906, there was a swarm of 42 felt earthquakes near Soccoro, New Mexico, with the largest two having maximum MM intensities of VII. The November 15 earthquake is listed as the largest in New Mexico history. Soccoro lies 187 miles west-northwest of the site, in the central part of the Rio Grande rift. The epicentral location cited by USGS-NEIC for these events is rounded off to the nearest whole degree of latitude and longitude, which indicates considerable uncertainty in the location.

The July 12, 1906 event is described as follows on the NEIC website (9-062):

> *"About 110 kilometers south of Albuquerque at Socorro, an earthquake threw down several chimneys, knocked plaster from the walls of many adobe houses and the courthouse, and hurled shelf goods, book cases, and dishes to the floor. The entire business block, extending from the plaza along the north side of Manzanares Avenue, was damaged heavily. A two-story brick house, one of the buildings most severely damaged, was abandoned because its walls were cracked badly and thrown out of plumb. Nearby, one of the walls of another cottage was damaged so severely that the occupants moved outside to a tent. Many other residences sustained damage to walls and furniture.*
>
> *Many boulders rolled onto the branch railroad leading to Magdalena, west of Socorro, breaking one rail and many ties. Fissures formed in the ground near the Santa Fe depot in Socorro, and waves were seen on the ground surface. The earthquake shook residents of Carthage, Kelly, Magdalena, San Antonio, San Marcial, and other towns as far north as Albuquerque and as far south as Silver City (Grant County). Tremors were felt daily from July 2, 1906, well into 1907"* (abridged from 9-042).

The November 15, 1906 event (MM VII), which occurred near the end of the temporal swarm, was identified as the "largest earthquake in New Mexico" and was described by NEIC (9-061) as:

> *"This earthquake, which increased the property damage already sustained at Socorro, was described as the most severe shock of the year. Four rebuilt chimneys were shaken off the Socorro County Courthouse, and two others were cracked severely. Plaster fell at the courthouse, and a cornice on the northwest corner of the two-story adobe Masonic Temple was thrown onto its first floor. Several bricks fell from the front gable on one house. Plaster was shaken from walls in Santa Fe, about 200 kilometers from the epicenter. Felt over most of New Mexico and in parts of Arizona and Texas* (abridged from 9-042).

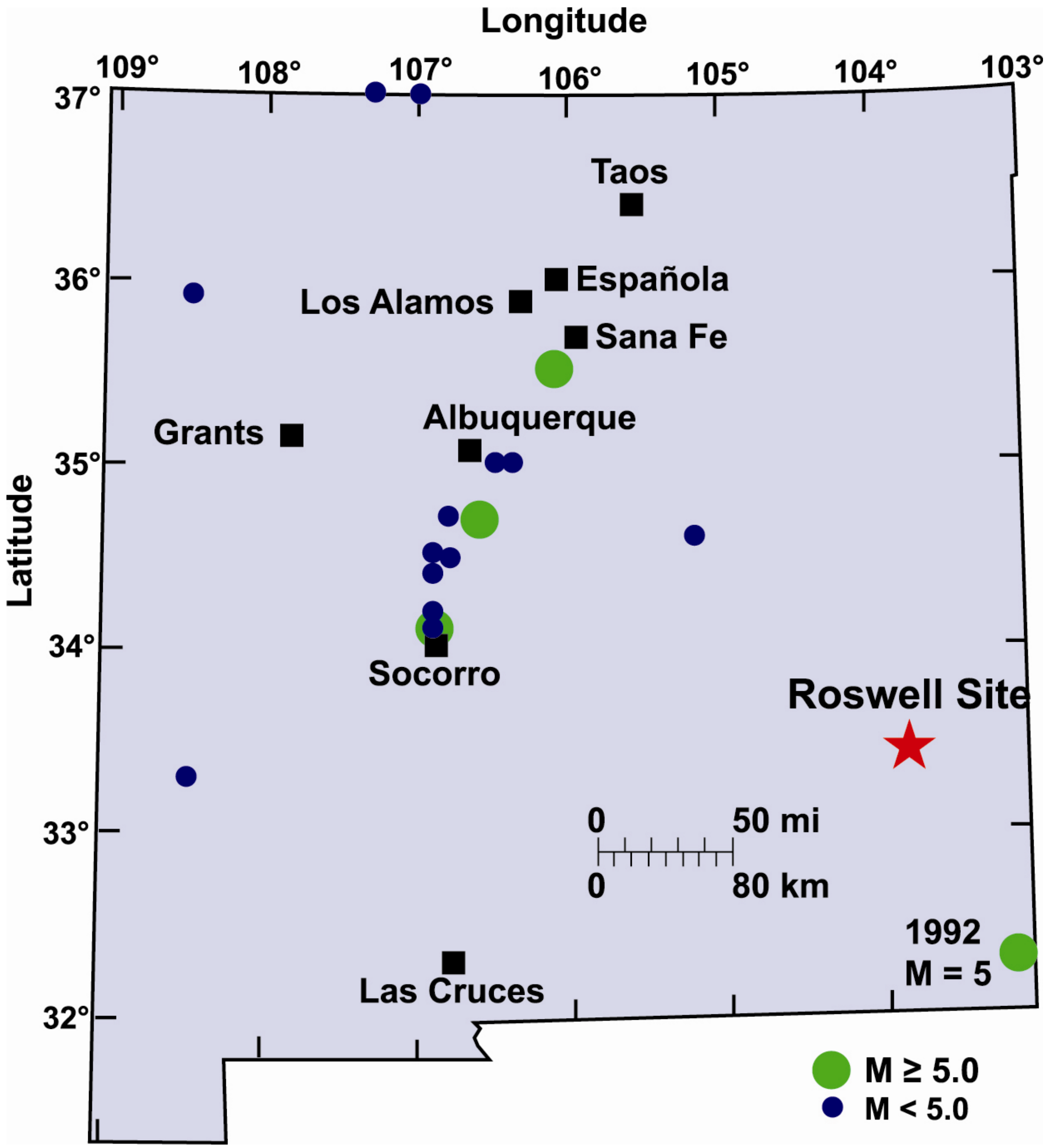


Figure 9-22. Strongest earthquakes in New Mexico, 1869 – 1998, M 4.5 or greater. Number in parentheses indicates multiple events at that location (9-038).

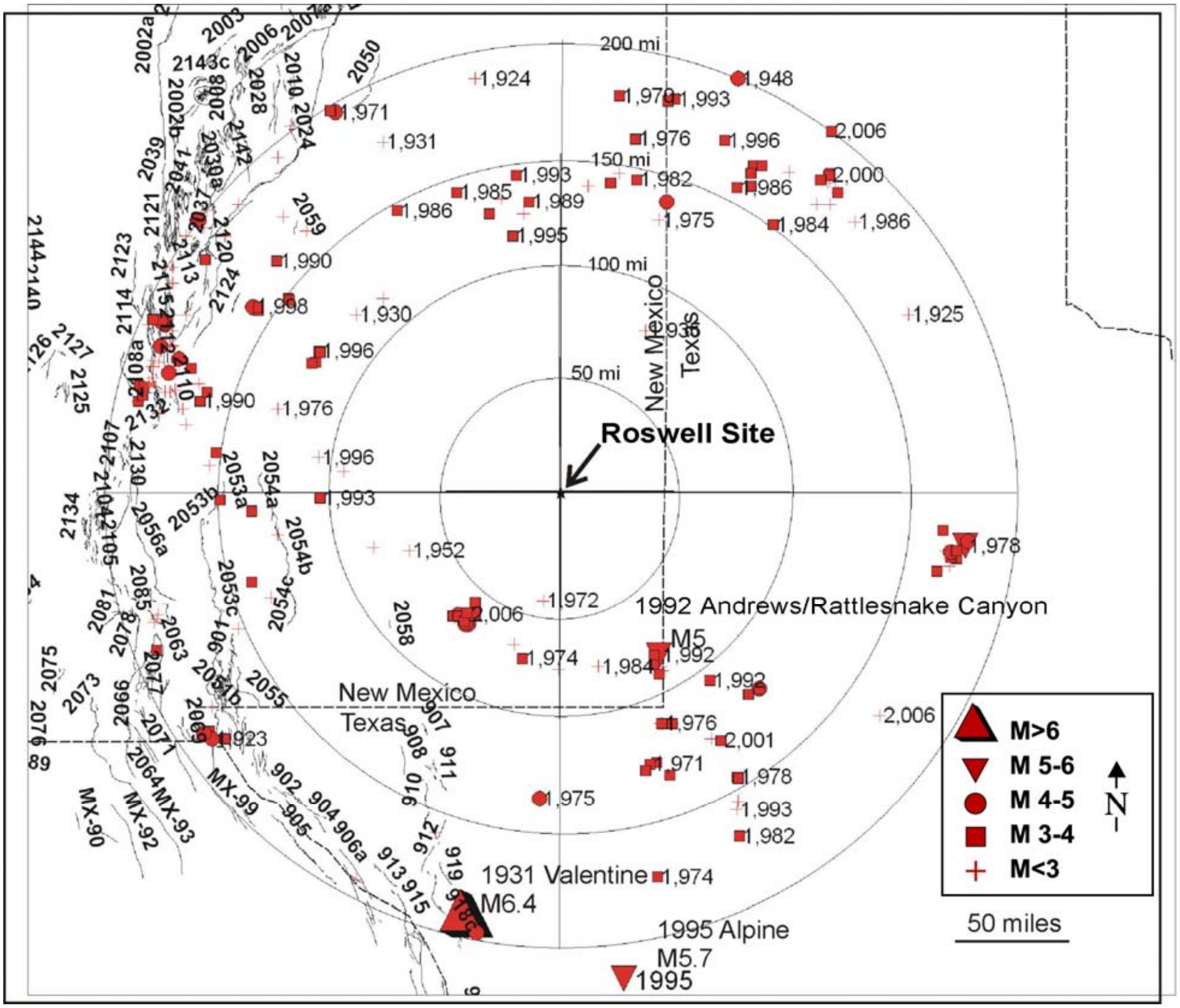


Figure 9-23. Earthquakes from three combined catalogs of the USGS. Labeled events are discussed in text. The 1992 Andrews event is referred to in the text as the 1992 Rattlesnake Canyon earthquake (9-048).

#2-- 1925 Panhandle, Texas (MM VI)

As shown on Figures 9-20 and 9-21, there is a cluster of earthquake epicenters in the northern part of the Texas Panhandle. The largest event to occur there occurred on July 30, 1925, and had a maximum intensity of VI on the Rossi-Forel scale. This earthquake has been described as follows (9-034):

> "*The epicenter of these earthquakes was in the vicinity of the towns of Cuyler, Panhandle, and Plemons (Figure 9-24), where the effects just noted were experienced. At Plemons, plaster fell, and jars were displaced from shelves. At Cuyler, a vase was overturned and milk crocks spilled their contents. At Panhandle, a decrepit coal bin failed and coal poured out at one side on to the ground. In these towns everyone was aware of the disturbance and alarmed by it. At White Deer, a minor shock was noted by several people about noon of the day following the main earthquake; no one outside of White Deer appears to have been aware of this second shock. At Amarillo, the earthquake was generally noticed but its effect was mild; windows rattled, mirrors oscillated, and beds creaked, according to various witnesses.*
>
> *The shocks were distinct as far west as Clovis, Tucumcari, and Raton, New Mexico, and as far east as Belva, Oklahoma. At Clarendon, Texas, people were so disturbed as to run from their homes in spite of a heavy fall of rain. Roswell, New Mexico, 225 miles to the southwest, felt the shocks, as did Tulsa, Oklahoma, 300 miles to the east, and Leavenworth, Kansas, 400 miles to the northeast. St. Regis College at Denver, Colorado, recorded a seismic disturbance at 6:20 a.m., which lasted three minutes. Georgetown University recorded earth shocks from 7:15 to 8:00 a.m. Eastern Standard Time, with maximum intensity at 7:20 a.m.*
>
> *No fissures or other evidence of displacement by the earth movement were noted. At Cuyler, according to the testimony of the roadmaster of the Santa Fe Railroad, it was necessary to do considerable work on the track, which he thought might have been due to settling caused by the earthquake.*
>
> *Considering the evidence in the foregoing paragraphs, this earthquake may be classed as of the VI order of the Rossi-Forel scale of intensity."*

There are no faults mapped at the surface in the epicentral area. However, the following speculations about the tectonic structure responsible for this earthquake have been made (9-034):

> "*Oil-well records have established, however, the presence of a former range of granite mountains now completely submerged and covered over by the Permian Red Beds, so that the highest peaks are buried about 2,500 feet beneath the present surface. The axis of this buried mountain range trends west-northwest through a point about fifteen miles north of Panhandle. The range has been traced westward beneath the surface for a distance of one hundred miles and to the east-southeast its presence has been established at intervals over an equal distance, Or to a point where it resolves itself clearly into a subsurface westward continuation of the Wichita Mountains of western Oklahoma. These mountains, it will be recalled, consist of Pre-Cambrian granite, and the buried granite ridge to the westward is made up of strikingly similar rock. This geologic feature, the buried westward continuation of the Wichita Mountains, has been described by Sidney Powers, Economic Geology 17, 233, 1922, and by the present writer in the Bulletin of the American Association of Petroleum Geologists, 7, 237, 1923.*

Along the southern margin of this buried granite ridge in the vicinity of the town of Panhandle, that is, near the epicenter of the recent earthquake, the relief of the former mountain surface is extreme. Differences of 1,500 - 2,000 feet in elevation of the old surface are proven over horizontal distances of only a few miles. The accompanying outline map shows contours on the upper surface of a Permian limestone which is bowed up in an arch over the buried range of granite peaks, From the steep south dip on this surface one can infer the much greater abruptness with which the underlying granite surface must fall to the south. The general surface elevation is about 3,000 feet above sea-level. The contours on the upper surface of the Permian limestone range from 1,000 - 2,000 feet above sea-level on top of the arch which overlies the granite ridge, and fall to sea-level or lower away from the granite. On the arch the granite is encountered from 600 - 800 feet beneath the limestone, but away .from the ridge this interval is much greater. As a matter of fact, no well has gone deep enough to find the granite except near the axis of the buried range.

The suggestion is that the south margin of these Pre-Cambrian rocks is marked by a fault plane, with profound Pre-Permian displacement, and that the earthquakes in this region have been caused by renewed, sudden movement along this old line of weakness."

If these speculations are correct, the 1925 earthquake was generated by a buried fault that has no surface expression. This conclusion would have implications for the site, inasmuch as other unmapped, buried faults could exist much closer to the site.

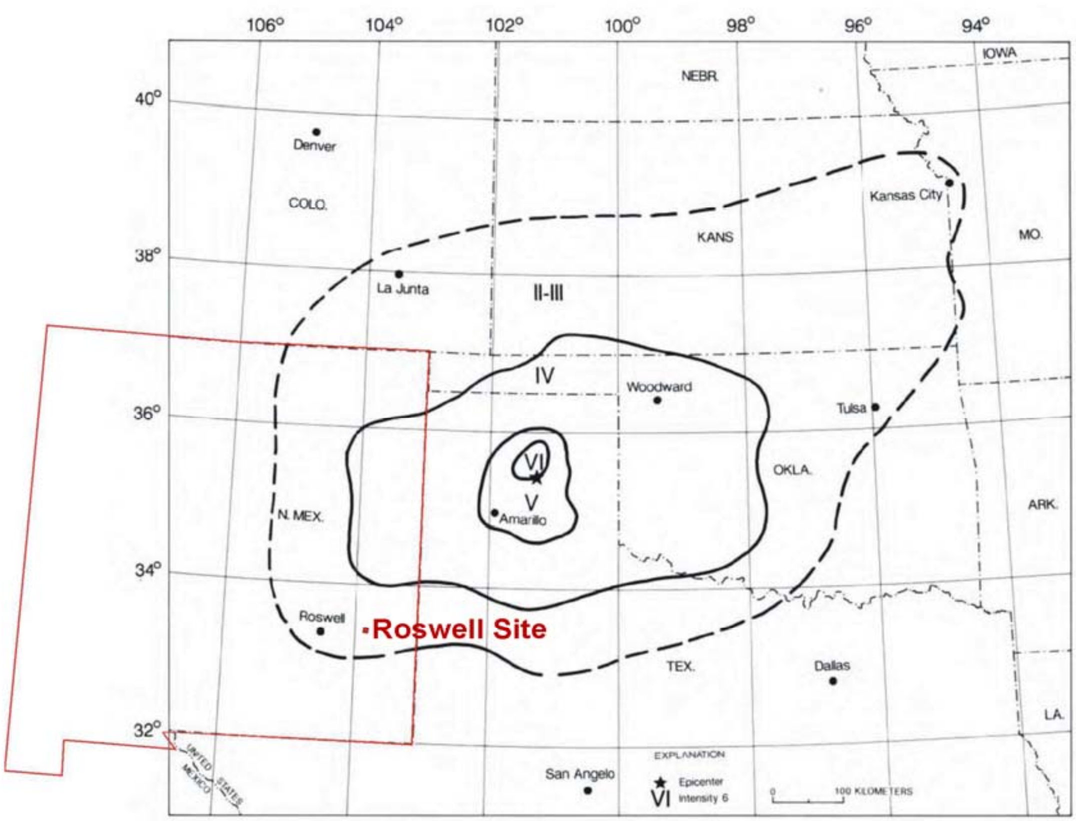


Figure 9-24. Isoseismal map of the 30 July 1925 Panhandle, Texas earthquake. Maximum MM intensity was VI in the epicentral area north of Amarillo. At the site the predicted intensity from this event would have been II-III (9-042).

#3--1931 Valentine, Texas (MM VIII)

The 1931 Ma 6.4 Valentine earthquake is the largest known earthquake in Texas with a maximum MM intensity of VIII (9-020). The magnitude of this event has been calculated as Ma 6.3 (9-020) and 5.8 (9-063). This event is the largest historic earthquake to have occurred within a 200-mile radius of the site; the epicenter was 192 miles south southwest of the site.

Damage occurred in the town of Valentine where buildings were severely damaged with the exception of wood-framed structures (9-042). Damaged property was reported in Brewster, Jeff Davis, Culberson, and Presidio Counties. The earthquake likely produced landslides throughout west Texas including the Van Horn Mountains, Chisos Mountains, and Guadalupe Mountains. The site probably underwent MM intensity IV ground shaking in this event (Figure 9-25). This event has been described as follows:

> "*In terms of magnitude and damage, this is the largest earthquake known to have occurred in Texas. The most severe damage was reported at Valentine, where all buildings except wood-frame houses were damaged severely and all brick chimneys toppled or were damaged. The schoolhouse, which consisted of one section of concrete blocks and another section of bricks, was damaged so badly that it had to be rebuilt. Small cracks formed in the schoolhouse yard. Some walls collapsed in adobe buildings, and ceilings and partitions were damaged in wood-frame structures. Some concrete and brick walls were cracked severely. One low wall, reinforced with concrete, was broken and thrown down. Tombstones in a local cemetery were rotated. Damage to property was reported from widely scattered points in Brewster, Jeff Davis, Culberson, and Presidio Counties. Landslides occurred in the Van Horn Mountains, southwest of Lobo; in the Chisos Mountains, in the area of Big Bend; and farther northwest, near Pilares and Porvenir. Landslides also occurred in the Guadalupe Mountains, near Carlsbad, New Mexico, and slides of rock and dirt were reported near Picacho, New Mexico. Well water and springs were muddied throughout the area. Also felt in parts of Oklahoma, New Mexico, and in Chihauhua and Coahuila, Mexico.*" (9-063).

A focal mechanism showed normal faulting with nodal planes oriented northwest-southeast parallel to the Mayfield section of the West Lobo Valley fault (USGS no. 918c, 918d; also called the Mayfield fault) which has shown evidence for movement in the Quaternary. The T-axis for the earthquake shows extension in a northwest-southeast direction. This is somewhat consistent with geologic stress indicators in the rest of the Basin and Range Province (9-020).

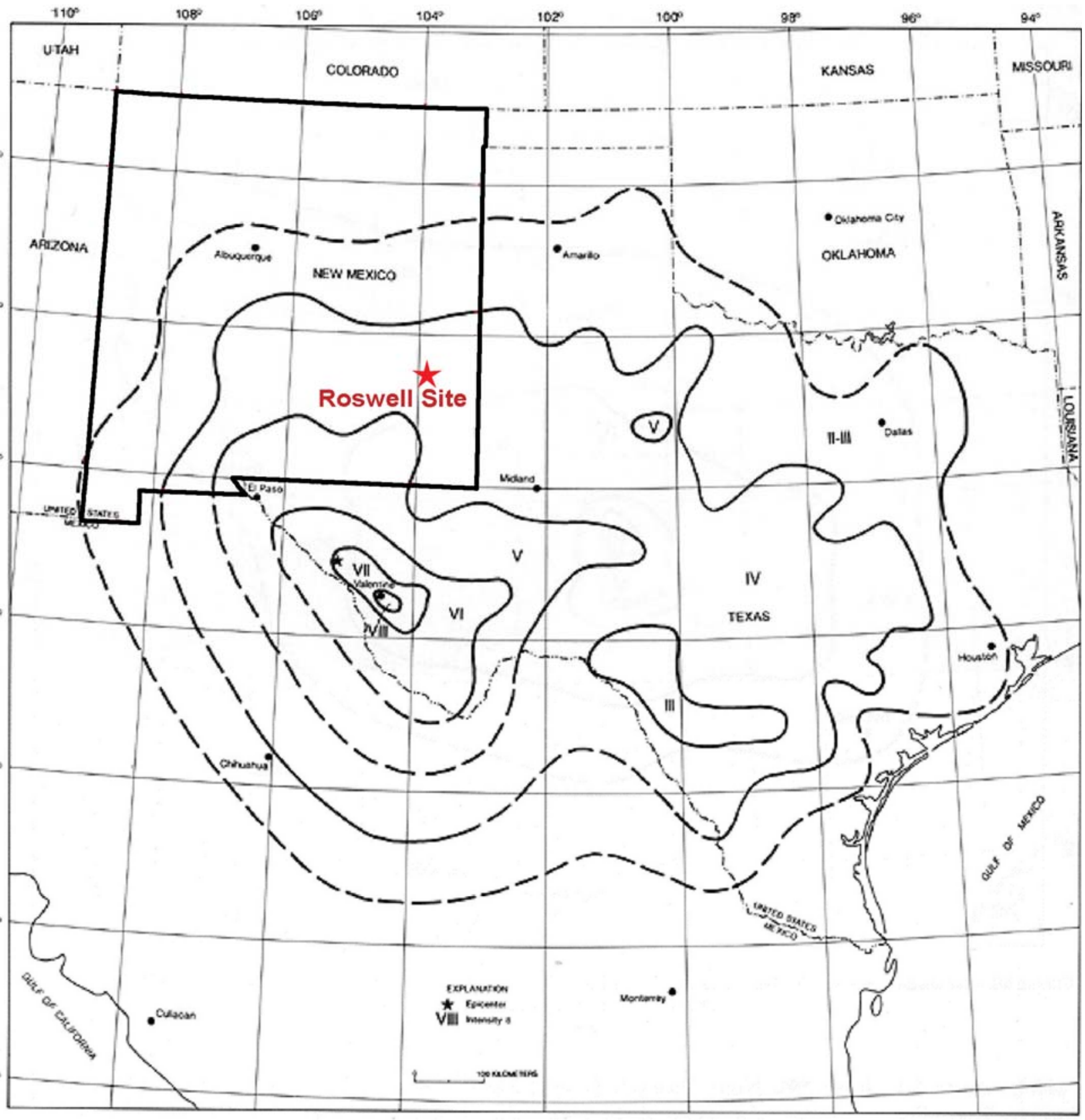


Figure 9-25. Isoseismal map of the 1931 Valentine earthquake. The predicted intensity at the site from this event would have been IV (9-063).

#4-- 1992 Rattlesnake Canyon , New Mexico/Texas (MM V)

On 2 January 1992, the Rattlesnake Canyon earthquake occurred in the Central Basin Platform near the southeastern New Mexico/west Texas border. This is the closest significant earthquake to have occurred within 200 miles of the site, because the epicenter lay only 83 miles southeast of the site. Magnitude estimates for the event range from Ma 4.6 to 5.0 (9-037). The earthquake was felt in southeastern New Mexico and west Texas; from Ruidoso, New Mexico to Abilene, Texas; and Amarillo to Ozona, Texas; and in high-rise buildings in San Antonio, Texas. The largest intensity felt was MM V at Seagraves, Texas, and Jal, Lakewood, Loco Hills and Roswell, New Mexico (9-065).

The Rattlesnake Canyon earthquake was located approximately 3 miles east of the Paleozoic West Platform fault. The Rattlesnake Canyon earthquake was interpreted as a reverse fault (9-037), with movement consistent with the approximately east to west maximum horizontal stress orientation determined by others (9-045). A focal mechanism indicated an oblique normal motion that is considered consistent with motion along the West Platform fault zone (9-021).

The earthquake was located in the vicinity of an oil field that was undergoing enhanced recovery operations at the time of the event. Locations by the New Mexico Institute of Mining and Technology (32°17.80N, -103°10.33W) and the USGS (32°20.16N,-103°06.06W), although separated by a distance of 6.2 miles, place the earthquake less than 9.3 miles from the Dollarhide Oil Field (9-021). A calculated focal depth is not sufficiently constrained to determine if the event was shallow enough to have occurred within active drilling depths (9-037), but it has been suggested that the hypocentral depth ca. 7.5 miles, well below active drilling (9-021)

Focal mechanisms computed for the 1992 earthquake have been inconsistent primarily due to poor depth constraint. A focal mechanism that displays north-northwest planes and reverse faulting (9-037), and a mechanism that indicates north-northwest-trending oblique-normal faulting consistent with regional stress directions (9-021), have both been suggested

#5-- 1995 Alpine (also called Marathon), Texas (MM VI)

The second largest earthquake in Texas history, a Ma 5.7 event, occurred on April 14, 1995 near Alpine, in Brewster County (Figure 9-26). The epicenter is cited by USGS-NEIC (9-065) as 30.28°N, -103.35°W, which places it slightly more than 200 miles south of the site. Felt reports included damaged water mains and a broken fire hydrant, cracked walls and windows, broken dishes, and dislodged suspended ceilings. Newspaper reports stated broken gas mains resulted in several small fires (9-024). Landslides were reported near the peak of Cathedral Mountain. The earthquake was felt from San Antonio to Sierra Blanca, Texas and as for north as Roswell, New Mexico (Figure 9-26).

The Alpine earthquake occurred in that part of west Texas occupied by extensional normal faults related to the Rio Grande rift. However, according to the Quaternary Fault and Fold database of the USGS (9-044), there are no Quaternary faults in close proximity to the epicenter. The nearest Quaternary fault lies 31 miles south of the epicenter (unnamed fault east of Santiago, USGS fault no. 917), so it unlikely to be the causative fault. Therefore, the Alpine earthquake probably did not occur on a recognized (mapped) fault, and should be treated as a background earthquake.

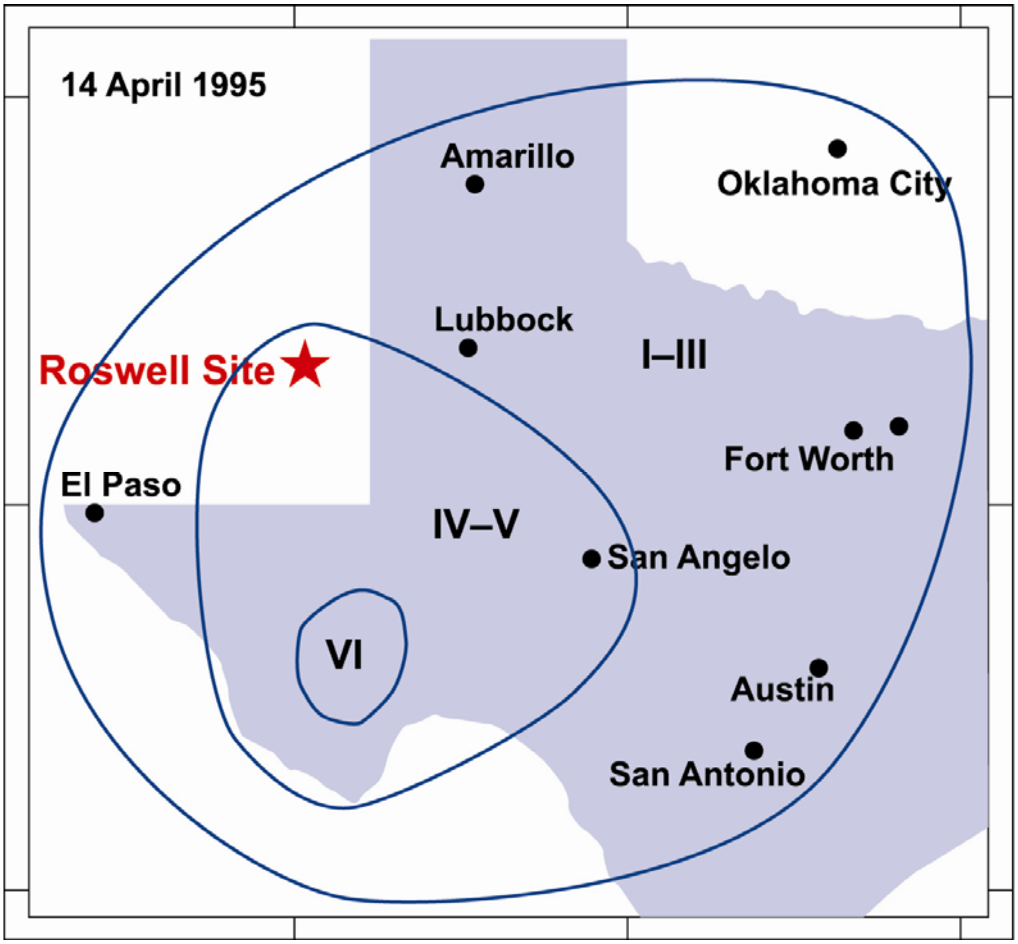


Figure 9-26. Isoseismal map of the April 14, 1995 Alpine, Texas earthquake (Ma 5.7). The predicted intensity at the site from this event would have been IV (9-043).

9.3.1.7 Induced Seismicity

Previous studies of seismicity have shown that earthquakes can result from fluid injection and withdrawal into the earth's crust including from the production of oil and gas or enhanced recovery operations (9-035 and 9-027) (Figure 9-27). The following discussion is taken from a report related to the Waste Control Specialists (WCS) site in west Texas (9-043).

The Permian Basin of west Texas lies just to the east of the site, and represents the largest petroleum-producing basin in the continental U.S. (9-022). Injection of fluids for secondary recovery operations occurs at over 3,000 sites in Texas (9-019). Enhanced recovery operations began in the 1950s and continue today. Historical seismicity spatially correlates with known active oil fields (9-035, 9-027, 9-021). The onset of secondary recovery operations in the Central Basin Platform is coincident with initiation of seismicity in the region beginning in 1966 with the first felt event (9-036 and 9-041). Various studies (9-035, 9-027, 9-053, and 9-021) show seismicity in the Central Basin Platform to be associated with at least three oil fields in the area: the War-Wink gas field in Ward County; the Kermit-Keystone oil and gas fields in Winkler County, and the Apollo-Hendrick oil and gas fields in Winkler County. Deeper earthquakes in the basin are thought to be associated with tectonic activity (9-027).

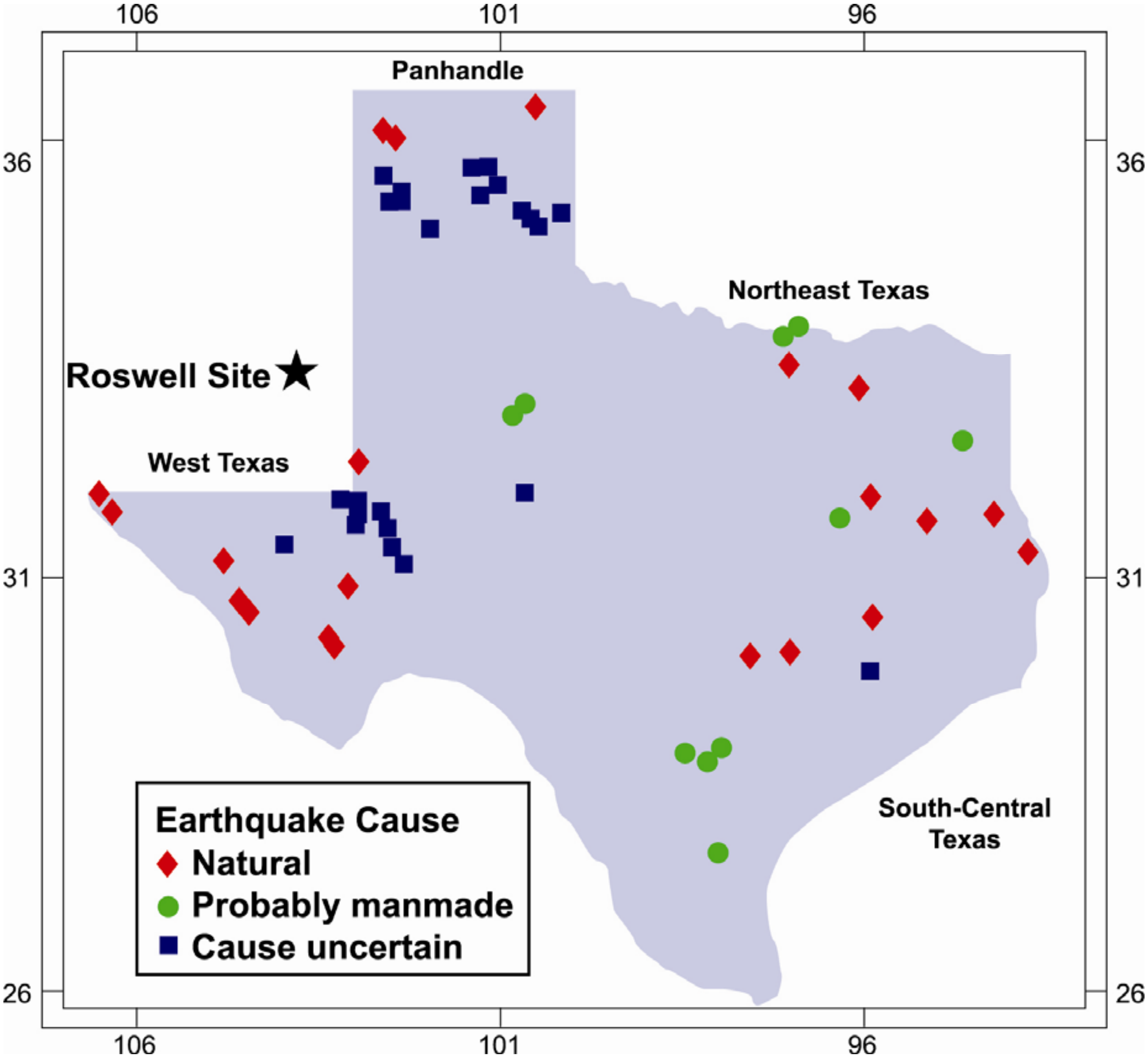


Figure 9-27. Map showing probable causes of earthquakes in Texas. Note that the scattered earthquakes in far west Texas are interpreted as natural, stemming from extensional faulting in the Texas part of the Rio Grande rift. In contrast, the cluster of earthquakes directly to the northeast of the rift (opposite the southeast corner of New Mexico) is labeled "cause uncertain," because both induced and natural events have occurred (9-040).

Possible induced seismicity closer to the site was also observed in the Dollarhide field. The Permian Basin Seismic Network recorded earthquakes in the vicinity between Ma 0.9 and 2.9 during 1976 and 1977. Secondary oil and gas recovery is expected to continue for at least decades in west Texas (9-043). Spatial correlation between seismicity and secondary recovery operations near the Kermit and Keystone oil and gas fields suggests that seismicity could continue tens of years after production has ceased. Thus induced seismicity will continue to contribute to the future earthquake activity within a 200-mile radius of the site.

9.3.1.8 Correlation of Epicenters of Highest Intensity Historical Earthquakes with Tectonic Structures

This section provides material required by 10 CFR 100, Appendix A Section IV(a)(6). The information presented in this section can be summarized as follows:

- About half of the Ma > 2 earthquakes in the site region as associated with the Rio Grande Rift or related features. The cluster of earthquakes near Socorro, New Mexico is related to this structure;

- In the Great Plains province, which includes the site, there is a cluster of earthquakes in Texas near the southeast corner of New Mexico; and

- The site is in a relatively aseismic area that lies between two more seismically active areas of the Great Plains province to the north and south.

Of the historic earthquakes of Ma > 2 in New Mexico and bordering areas, about half of them are associated with the Rio Grande rift zone, which trends north-south down the center of New Mexico, and its associated rift-flank uplifts in the Southern Rocky Mountains (Figure 9-28). A very concentrated cluster occurs in the Socorro Seismic Anomaly (9-038). For the Ma > 2 seismicity in the Great Plains province, in which the site is located, there is a prominent cluster of earthquakes in west Texas, opposite the southeast corner of New Mexico. This cluster includes natural events such as the 1992 Rattlesnake Canyon event (Ma 5), which occurred at its northwest end, but also may include a large component of induced earthquakes. The overall northwest trend of the earthquake cluster parallels that of the structural grain in the Central Basin Platform of west Texas, as typified by faults such as the West Platform fault (9-021). Such an alignment is not unexpected, because even induced earthquakes may occur on small faults that parallel major faults and the structural grain.

The Ma > 3 earthquakes in New Mexico and bordering areas generally conform to the pattern described above (Figure 9-29). However, at this magnitude level there is little seismicity in the southern part of the Great Plains province of New Mexico, where the site is located. Instead, almost all of the Ma > 3 seismicity is located in the northern part of the Great Plains province of New Mexico, and lies within the Jemez Lineament or the Socorro Fracture Zone. These structures trend east-northeast, in contrast to the structural grain in west Texas that trends northwest and seems to control the occurrence of earthquakes there. Seen in this light, the area of the Great Plains in which the site is located is a relatively aseismic area that lies between two more seismically active sections of the Great Plains to the north and south.

Of the five historic earthquakes of highest intensity (the five historic Ma > 5 earthquakes described previously), three occurred in the Rio Grande rift tectonic province (1906 Socorro, New Mexico; 1931 Valentine, Texas; 1995 Alpine, Texas) (Table 9-10). Of these three, the causative fault is known only for the 1931 event. For the other two events, either the epicentral location is too uncertain to identify the causative fault (1906 Socorro, New Mexico), or there are no known Quaternary faults closer than 31 miles to a well-located epicenter (1995 Alpine, Texas).

For the two earthquakes that occurred in the southern High Plains province, there are speculations about the source tectonic structure that cannot be proven, due to the lack of surface rupture in both cases. For the 1925 Panhandle earthquake, it was speculated that the source structure was an unnamed buried fault formed during the late Paleozoic Ouachita Orogeny (9-034). For the 1992 Rattlesnake Canyon earthquake, it was inferred that the source structure as the West Platform fault (9-021). This fault is also a late Paleozoic fault, originally expressed by right-lateral slip. Such recent activity on a late Paleozoic fault has been documented elsewhere on the Great Plains, such as at the Meers fault in Oklahoma.

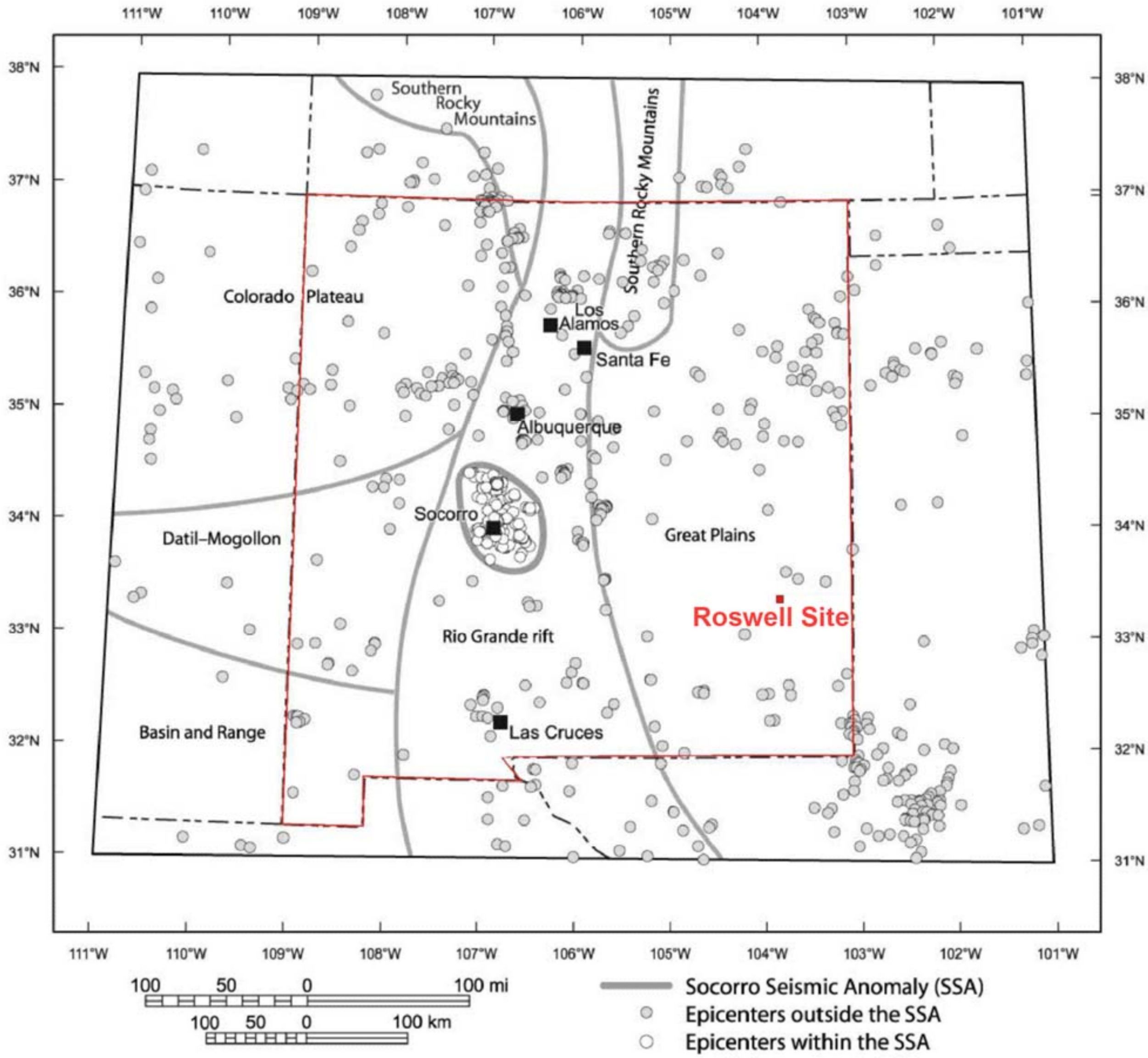


Figure 9-28. Seismicity of New Mexico and bordering areas, latitude 31° to 38° N, longitude 101° to 111°W, 1962 to 1998, MM 2.0 or greater. A total of 789 earthquakes are plotted on this map, 215 of which are inside the Socorro Seismic Anomaly (enclosed by gray line) (9-038).

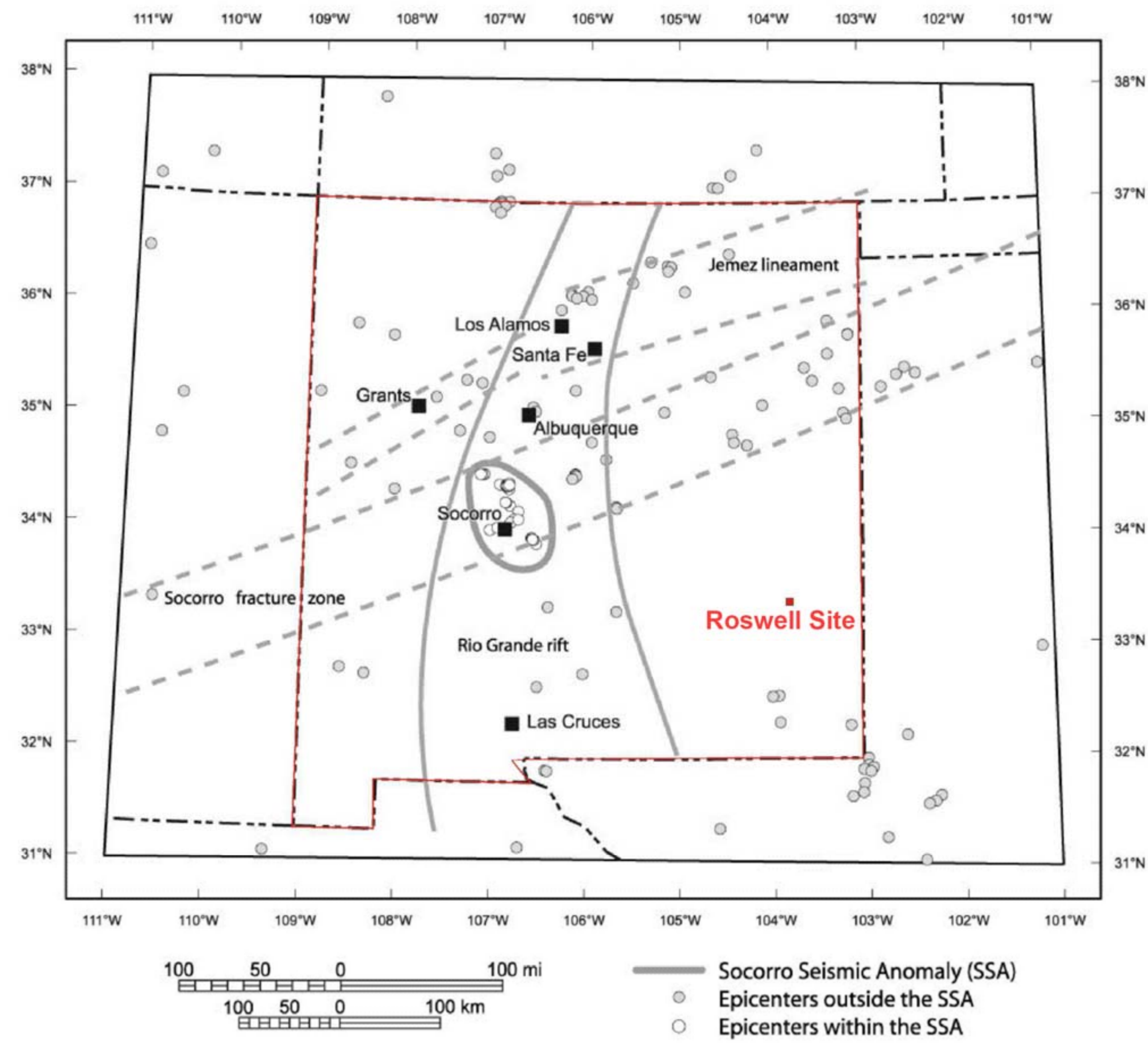


Figure 9-29. Seismicity of New Mexico and bordering areas, latitude 31° to 38° N, longitude 101° to 111°W, 1962 to 1998, MM 3.0 or greater (9-038).

Table 9-10. Summary of information about the tectonic sources of highest intensity earthquakes.

Earthquake	Associated Tectonic Structure and reference	Tectonic Province
#1-- 1906 Socorro, New Mexico (MM VII)	Unknown; epicentral location poorly known, and many Quaternary faults in area (9-061, 9-062)	Rio Grande rift
#2-- 1925 Panhandle, Texas (MM VI)	Unknown; possibly a buried fault formed during the Ouchita Orogeny (late Paleozoic) (9-034)	Southern High Plains
#3--1931 Valentine Earthquake (Ma 6.4)	Mayfield section, West Lobo Valley fault (USGS no. 918c) (9-020)	Rio Grande rift
#4-- 1992 Rattlesnake Canyon Earthquake (Ma 5)	Possibly the West Platform fault zone, a late Paleozoic right-lateral fault (9-021)	Southern High Plains
#5-- 1995 Alpine Earthquake (Ma 5.7)	Unknown	Rio Grande rift (tentative identification)

9.3.1.9 Evaluation of Fault Capability

This section provides information regarding fault capability required by 10 CFR 100, Appendix A Section IV(a)(7). The information presented in this section can be summarized as follows:

- There are 101 Quaternary faults within 200 miles of the site,
- Only eight exceed the minimum length as a function of distance from the site criteria specified in 10 CFR 100, Appendix A that require characterization as part of reactor siting studies, and
- Six of these eight faults are classified as capable, based on evidence of movement during the recent geologic past.

Nuclear Regulatory Commission (NRC) regulations (9-031) require that geologic faults within a 200-mile radius of the site be examined as possible capable seismic sources. To perform this examination, information from the Quaternary Fault and Fold Database of the U.S. (9-044) was imported into geographic information system (GIS) software, and a 200-mile radius circle centered at the site (33.3645°N and 103.8486°W was drawn. There are 101 Quaternary faults within a 200-mile radius of the site listed in the Quaternary Fault and Fold Database of the U.S. (9-044). These faults all lie northwest, west, and southwest of the site, in the Rio Grande rift zone. There are no known Quaternary faults east of the site within the 200-mile radius.

Only faults that exceed a minimum length as a function of distance from the site must be considered during characterization of the Safe Shutdown Earthquake (Table 9-11). These parameters were used as screening criteria to identify faults that should be retained for further consideration. Of the 101 faults within a 200-mile radius, only eight faults exceed the minimum length specified by Appendix A (see Table 9-12).

The next step in the screening process was to determine if the eight faults were capable, as defined in 10 CFR 100, Appendix A. To make this determination, the Complete Report for each fault in the Quaternary Fault and Fold Database of the USGS (9-044 and 9-048) were examined. The criteria used to assess capability are described in 10 CFR 100, Appendix A (9-031):

A capable fault *is a fault which has exhibited one or more of the following characteristics:*

1. *Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years,*

2. *Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault, and*

3. *A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.*

In some cases, the geologic evidence of past activity at or near the ground surface along a particular fault may be obscured at a particular site. This might occur, for example, at a site having a deep overburden. For these cases, evidence may exist elsewhere along the fault from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence shall be used in determining whether the fault is a capable fault within this definition.

Notwithstanding the foregoing paragraphs III(g) (1), (2) and (3), structural association of a fault with geologic structural features which are geologically old (at least pre-Quaternary) such as many of those found in the Eastern region of the United States shall, in the absence of conflicting evidence, demonstrate that the fault is not a capable fault within this definition.

Based on the information in the Complete Reports (9-044), two of the eight faults did not exhibit compelling evidence for being capable faults (Unnamed faults on the Llano de Manzano, West Robledo fault). The other six faults were deemed to be capable, and are described in the next section.

Table 9-11. Minimum lengths for capable faults that must be characterized based on their distance from the Roswell site (adapted from 9-031).

Distance from the site (miles)	**Minimum length (miles)** [1]
0 to 20	1
Greater than 20, to 50	5
Greater than 50, to 100	10
Greater than 100, to 150	20
Greater than 150, to 200	40

[1] Minimum length of fault (miles) which shall be considered in establishing Safe Shutdown Earthquake.

Table 9-12. Characteristics of Quaternary faults that must be characterized by NRC regulations. These faults are capable according to the definitions in 10CFR Appendix A, and exceed the minimum fault length specified in Table 1 of 10 CFR 100, Appendix A (9-044).

Fault Name	USGS No.	Fault Section	Distance From site (miles)	Section Length (miles)	Fault Length (miles)	NRC Min Length (miles)	Fault Exceeds Min Length?	Slipsense	Dip Direction	Slip Direction	Age of Youngest Deposit Offset	Slip Rate (mm/yr)	Capable?	Reason
Alamogordo fault	2054	Sacramento Mountains	122	37.2	67.2	20	**YES**	Normal	Southwest	Southwest	<15,000	<0.2	**YES**	Multiple Recurrent Events 10-15 ka
	2054	Three Rivers	125	21	67.2	20	**YES**	Normal	Southwest	Southwest	<15,000?	<0.2	**YES**	Holocene Event
	2054	McGregor	127	9	67.2	20	**YES**	Normal	Southwest	Southwest	<130,000	<0.2	**YES**	Multiple Events In Mid-Late Pleistocene
East Sierra Diablo fault	910		141		20	20	**YES**	Normal	East	East	<130,000	<0.2	**YES**	Multiple Recurrent Events Late Pleistocene to Holocene
San Andres Mountains fault	2053	northern	148	15.6	68.8	20	**YES**	Normal	East	East	<130,000	<0.2	**YES**	Multiple Events in Mid-late Pleistocene
	2053	central	157	32	68.8	40	**YES**	Normal	East	East	<130,000	<0.2	**YES**	Multiple Recurrent Events at 25-35 ka
	2053	southern	158	22.2	68.8	40	**YES**	Normal	East	East	<15,000	<0.2	**YES**	Multiple Recurrent Events at 10+/-5 ka
Hueco fault zone	901		157		69.6	40	**YES**	Normal	East and West	East and West	<750,000	<0.2	**YES**	2-7 m Scarps in 130-400 ka
Tijeras-Canocito fault system	2033	Canyon	188	26.3	48.5	40	**YES**	Sinistral	Vertical	Right Lateral	<130,000	<0.2	**YES**	Multiple Events Since Mid-late Pleistocene
	2033	Galisteo	191	22.2	48.5	40	**YES**	Sinistral	Vertical	Right Lateral	<1,600,000	<0.2	**(NO)**	
Amargosa fault	905		191		41	40	**YES**	Normal	Northeast	Northeast	<15,000	<0.2	**YES**	Multiple Recurrent Events <15 ka
Unnamed faults on the Llano de Manzano	2117		177		42.5	40	**YES**	Normal	Unknown	Unknown	Unknown	Unknown	**Unknown**	Scarps 5-20 m High in Past 1 Ma
West Robledo fault	2064		187		64.4	40	**YES**	Normal	West	West	<1,600,000	<0.2	**NO**	

ka = thousand years
Ma = million years

9.3.1.10 Characteristics of Capable Faults

This section provides information about capable faults required by 10 CFR 100, Appendix A Section IV(a)(8). The information presented in this section can be summarized as follows:

- Five of the six capable faults have been characterized by the USGS,
- The sixth fault has yet to be characterized by USGS, and
- The predicted annual probability of the characteristic earthquake occurring at the five faults characterized ranges from 1.65×10^{-5} to 6.52×10^{-5}.

Within a 200-mile radius of the site there are six capable faults that must be characterized. Table 9-13 lists these faults and their seismotectonic characteristics as required by 10 CFR 100, Appendix A. These characteristics include: 1) the length of the fault; 2) the relationship of the fault to regional tectonic structures; and 3) the nature, amount, and geologic history of displacements along the fault, including particularly the estimated amount of the maximum Quaternary displacement related to any one earthquake along the fault.

Five of the six capable faults (excluding the Hueco fault zone) were characterized further by the USGS during preparation of the 2002 version of the National Seismic Hazard map (9-023) are shown in Figure 9-30. This characterization was necessary because the faults are included in the seismic hazard computer model as line sources of seismicity. The USGS characterization includes the slip rate, magnitude of the characteristic earthquake predicted for the fault, Characteristic Magnitude, and the annual probability of the characteristic earthquake (Table 9-14). USGS defines the characteristic earthquake following the original definition of Schwartz and Coppersmith (9-039).

Although three of the six faults (Alamogordo fault, San Andres Mountains fault, Tijeras-Canoncito fault) are each composed of three sections, the magnitude of the characteristic earthquake estimated for each (Ma 7.5, Ma 7.5, Ma 7.3) was based on the length of the entire fault (67.2 miles, 68.8 miles, and 48.5 miles, respectively). In other words, the conservative assumption was made that the characteristic earthquake could rupture all the fault sections simultaneously. For the shorter, unsectioned faults the magnitude was also estimated from total fault length (East Sierra Diablo fault, Ma 6.9; Amargosa fault, Ma 7.2). The slip rate and recurrence interval were estimated from the height of fault scarps on Quaternary geomorphic surfaces (pediments and alluvial fans) ranging in age from Holocene to early Pleistocene.

The Hueco fault zone was not included as a line source of seismicity in the National Seismic Hazard map. This omission requires explanation, considering that the Hueco fault zone contains numerous Quaternary faults in a zone 72 miles long, with an aggregate fault length of 313 miles, making it by far the longest fault zone within the 200-mile radius around the site. According to Russ Wheeler (9-067), the Hueco fault zone was possibly not included as a separate line source because there was uncertainty whether the many short fault scarps were independent seismic sources, or merely secondary faults that did not fully penetrate the seismogenic crust and thus did not release significant seismic energy.

Table 9-13. Characteristics of Quaternary faults that must be characterized by NRC regulations. These faults are capable according to the definitions in 10CFR Appendix A (NRC, 2007), and exceed the minimum fault length specified in Table 1 of Appendix A. Data are derived from fault reports in the USGS Quaternary Fault and Fold database (9-044).

Fault Name	USGS No.	Fault Section	Distance From site (miles)	Section Length (miles)	Fault Length (miles)	Relationship of the Fault to Regional Tectonic Structures	Nature of Displacements		Amount of Displacement (meters)	Maximum Displacement per Event in the Quaternary (meters)
							Slip Sense	Dip Direction		
Alamogordo fault	2054	Sacramento Mountains (b)	122	37.2	67.2	Rift-margin master fault within the Rio Grande rift	Normal	Southwest	2 m in Holocene, 10 m in late Pleistocene	2-3 m in Holocene (?) Multiple Recurrent Events
	2054	Three Rivers (a)	125	21	67.2	Rift-margin master fault within the Rio Grande rift	Normal	Southwest	18 m on Camp Rice formation, early Pleistocene	1-2 m (Phillips Hills)
	2054	McGregor (c)	127	9	67.2	Rift-margin master fault within the Rio Grande rift	Normal	Southwest	25 m on Camp Rice formation, early Pleistocene	No data
East Sierra Diablo fault	910		141		20	Rift-margin master fault within the Rio Grande rift	Normal	East	4 m since middle Pleistocene	1-2 m
San Andres Mountains fault	2053	Northern (a)	148	15.6	68.8	Rift-margin master fault within the Rio Grande rift	Normal	East	10-20 m on Camp Rice formation, early Pleistocene	No data
	2053	Central (b)	157	32	68.8	Rift-margin master fault within the Rio Grande rift	Normal	East	26-29 m since 250+/-50 ka	2.7-5.4 m
	2053	South (c)	158	22.2	68.8	Rift-margin master fault within the Rio Grande rift	Normal	East	22 m since 250+/-50 ka	2.8-4.8 m
Hueco fault zone	901		157		69.6	Distributed zone (swarm) of intra-rift faults	Normal	East and West	2-7 m since middle Pleistocene	No data
Tijeras-Canocito fault system, Canyon section	2033	b	188	26.3	48.5	Accommodation zone fault separating the Espanola Basin from the Albuquerque-Belen Basin	Sinistral	Vertical	No data	No data
Amargosa fault	905		191		41	Rift-margin master fault within the Rio Grande rift	Normal	Northeast	>24 m since middle Pleistocene	1-2 m

ka = thousand years
m = meter

Table 9-14. Seismic source parameters for the six capable faults within 200 miles of the Roswell site (9-066, 9-025).

Name	State	Slip Rate (mm/yr)	Dip (degrees)	Rupture Top (kilometers)	Width (kilometers)	Characteristic Magnitude (MM)	Annual Probability of the Characteristic Earthquake	Date of Compilation
Alamogordo fault	New Mexico	0.11	60	0	17	7.5	4.00E-05	08/19/2004
San Andres Mountains fault	New Mexico	0.1	60	0	17	7.5	3.91E-05	08/19/2004
Tijeras-Canoncito fault	New Mexico	0.09	90	0	15	7.3	3.28E-05	12/16/2004
East Sierra Diablo fault	Texas	0.02	60	0	17	6.9	1.65E-05	08/19/2004
Hueco fault					No data			
Amargosa fault	Texas	0.11	60	0	17	7.2	6.52E-05	08/19/2004

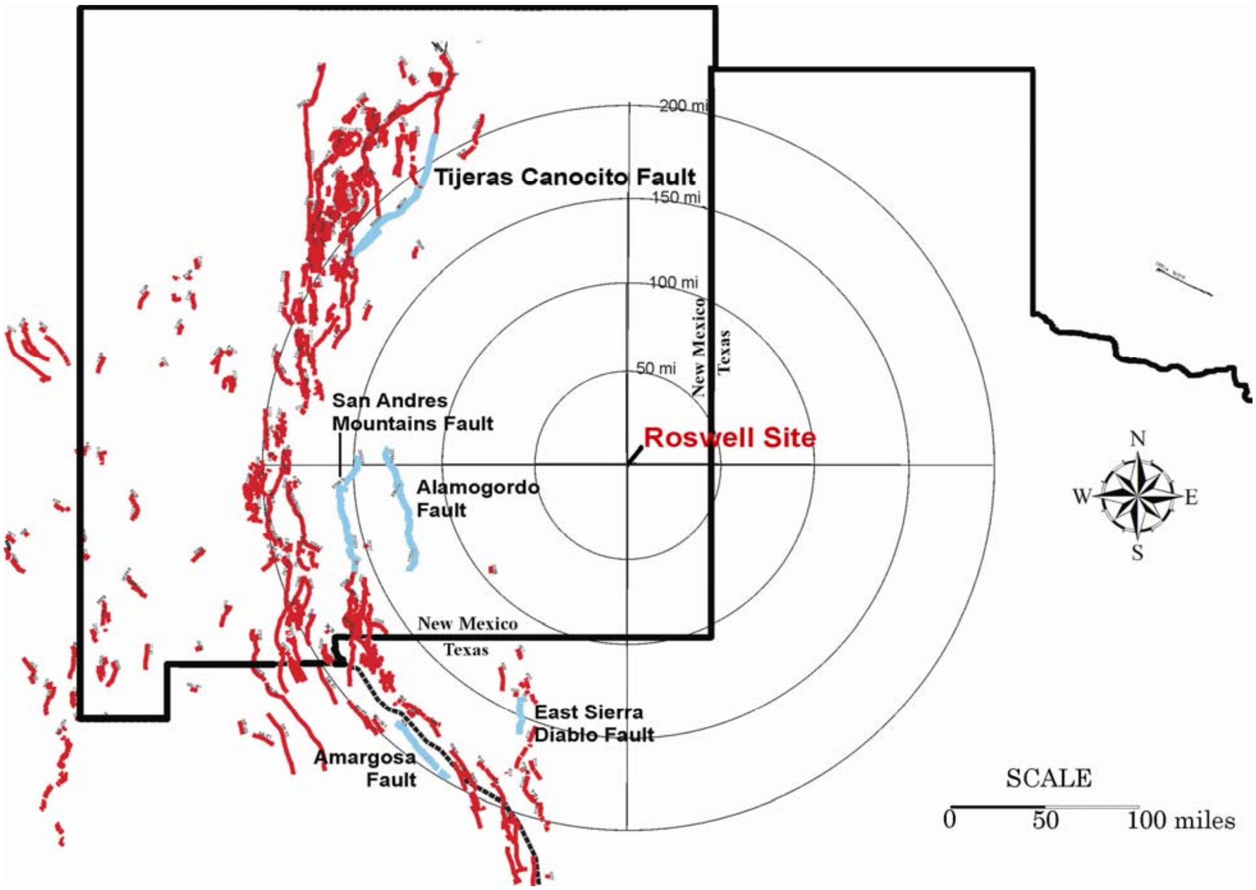


Figure 9-30. Capable faults within 200 miles of the Roswell site (9-023).

9.3.1.11 Summary of Vibratory Ground Motion at the site and Vicinity

The information presented in this section shows that predicted ground surface acceleration at the site due to earthquakes is low.

In 2002, the USGS issued the latest revision of the National Seismic Hazard Maps, which predict earthquake ground motions for all locations within the U.S. These maps were produced using a probabilistic seismic hazard analysis (PSHA) that incorporates both areal background zones of seismicity (based on historic seismicity, such as described in Sections 9.3.1.5 and 9.3.1.6), and active faults zones (such as the capable faults described in Sections 9.3.1.8 and 9.3.1.9).

The USGS maps of predicted ground motion from future earthquakes at the site and the surrounding regions are presented in this section. Figures 9-31 through 9-33 show the peak horizontal ground acceleration (PGA), 0.2-second spectral acceleration, and 1.0-second spectral acceleration predicted near the site for a 10 percent PE in 50 years (approximate return period of 475 years). Figures 9-34 through 9-36 show the PGA, 0.2-second spectral acceleration, and 1.0-second spectral acceleration predicted near the site for a 2.0 percent PE in 50 years (approximate return period of 2,475 years). The values predicted at the site are shown in Table 9-15.

The predicted ground motion values at the site are relatively low (0.01 to 0.05 g for 10 percent PE in 50 years; 0.04 to 0.12 g for 2 percent PE in 50 years). These low values reflect several factors at the site: 1) the low rates of historic earthquake occurrence in the area around the site, 2) the low magnitudes of such earthquakes, and 3) the far distance (generally 150 to 200 miles) to Quaternary faults capable of generating larger earthquakes (Ma > 6.5).

The ground motions shown in Figures 9-31 through 9-36 do not necessarily encompass deterministically-calculated ground motions, which would arise from a characteristic earthquake occurring on each of the six capable faults. Ground motion contributions from those capable faults are implicitly embedded in the National Seismic Hazard Maps, subject to the standard limitations of a probabilistic seismic hazard analysis. The maximum ground shaking that could occur at the site from those faults, independent of time period, may not be completely captured by the National Maps, even at the longer return period shown (2,475 years). That is because all six capable faults apparently have recurrence times (between characteristic earthquakes) longer than 2,475 years.

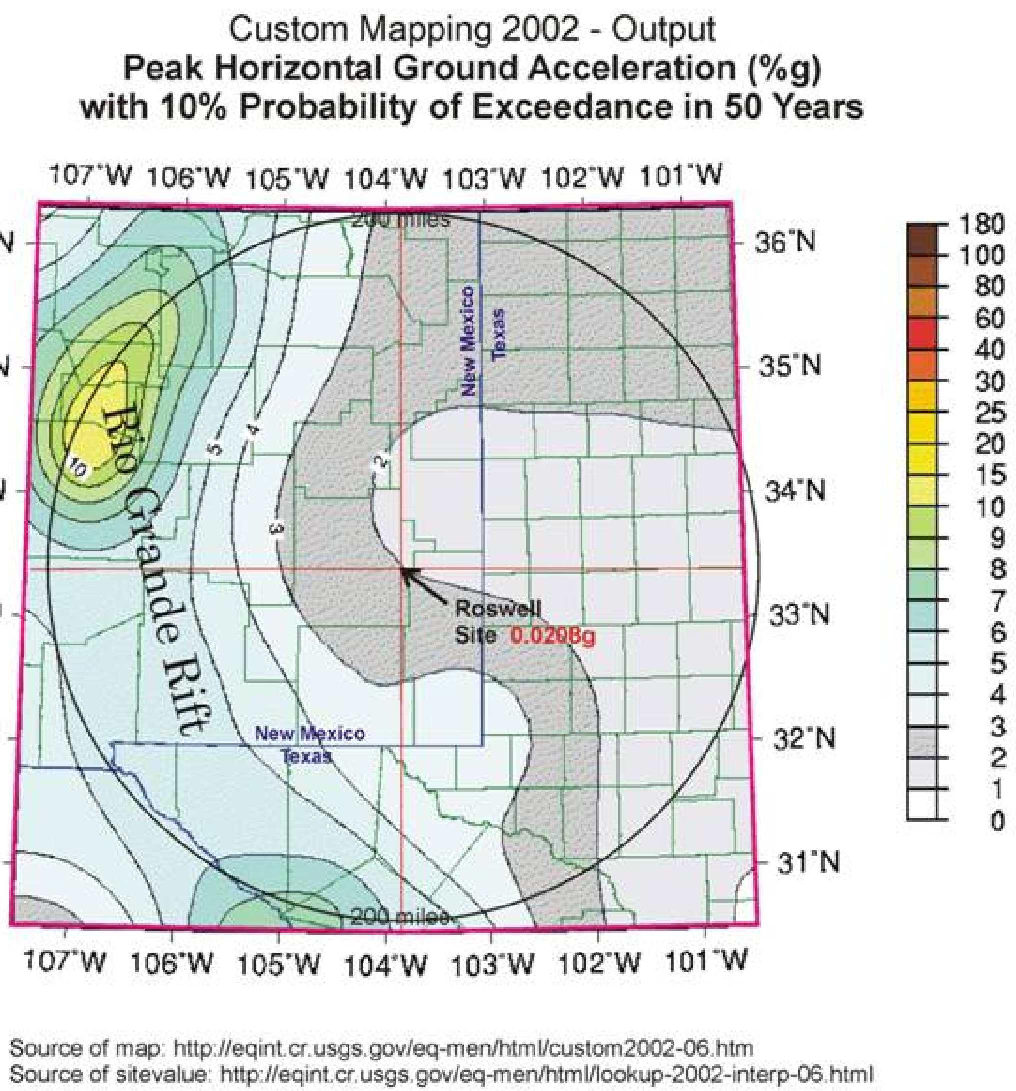


Figure 9-31. Peak horizontal acceleration (%g) with a 10 percent PE in 50 years (return period = 475 years). PGA at the site is predicted to be 0.0208 g (9-026).

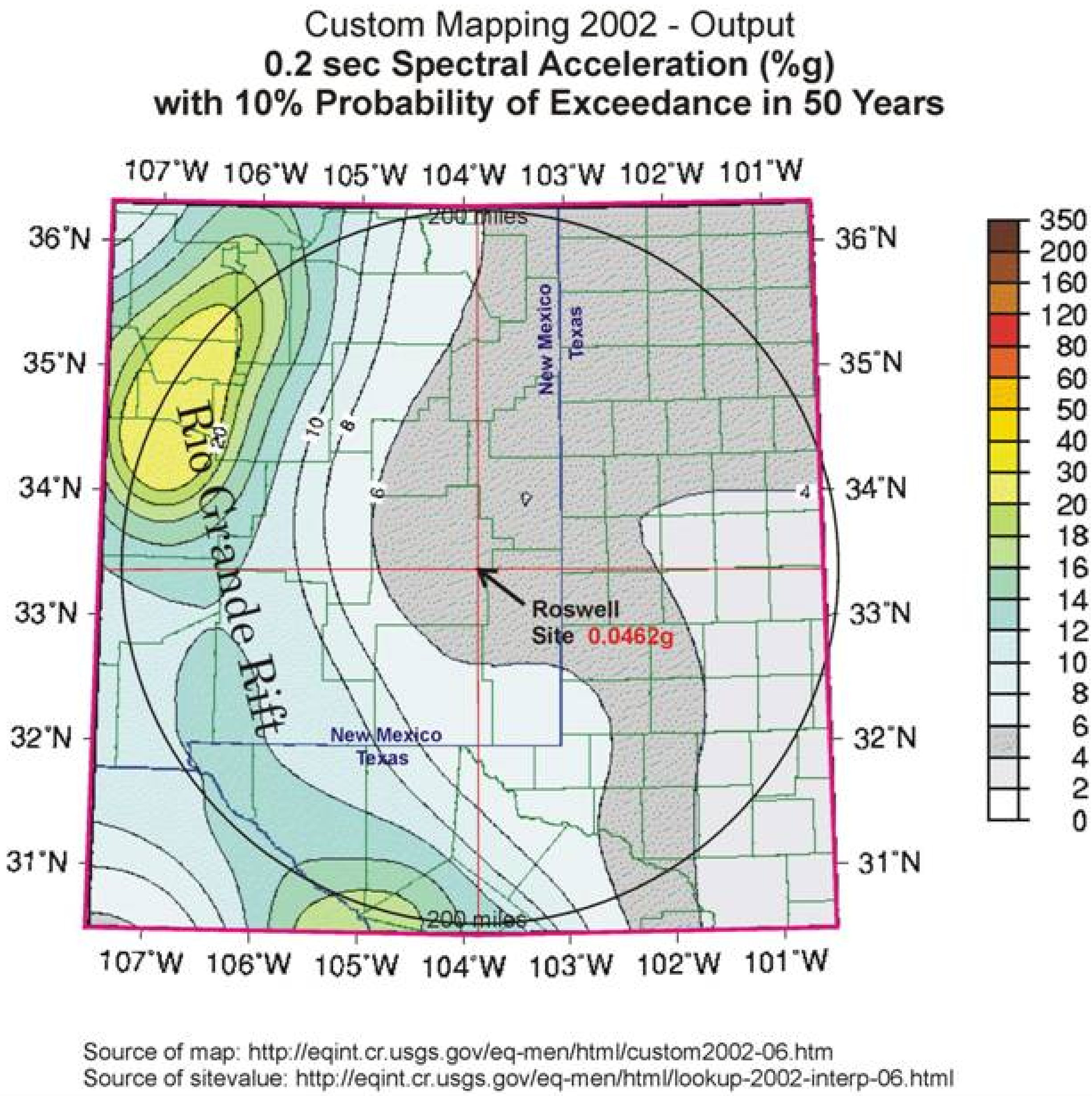


Figure 9-32. 0.2-second spectral acceleration (%g) with a 10 percent PE in 50 years (return period = 475 years). Spectral acceleration at the site is predicted to be 0.0462 g (9-026).

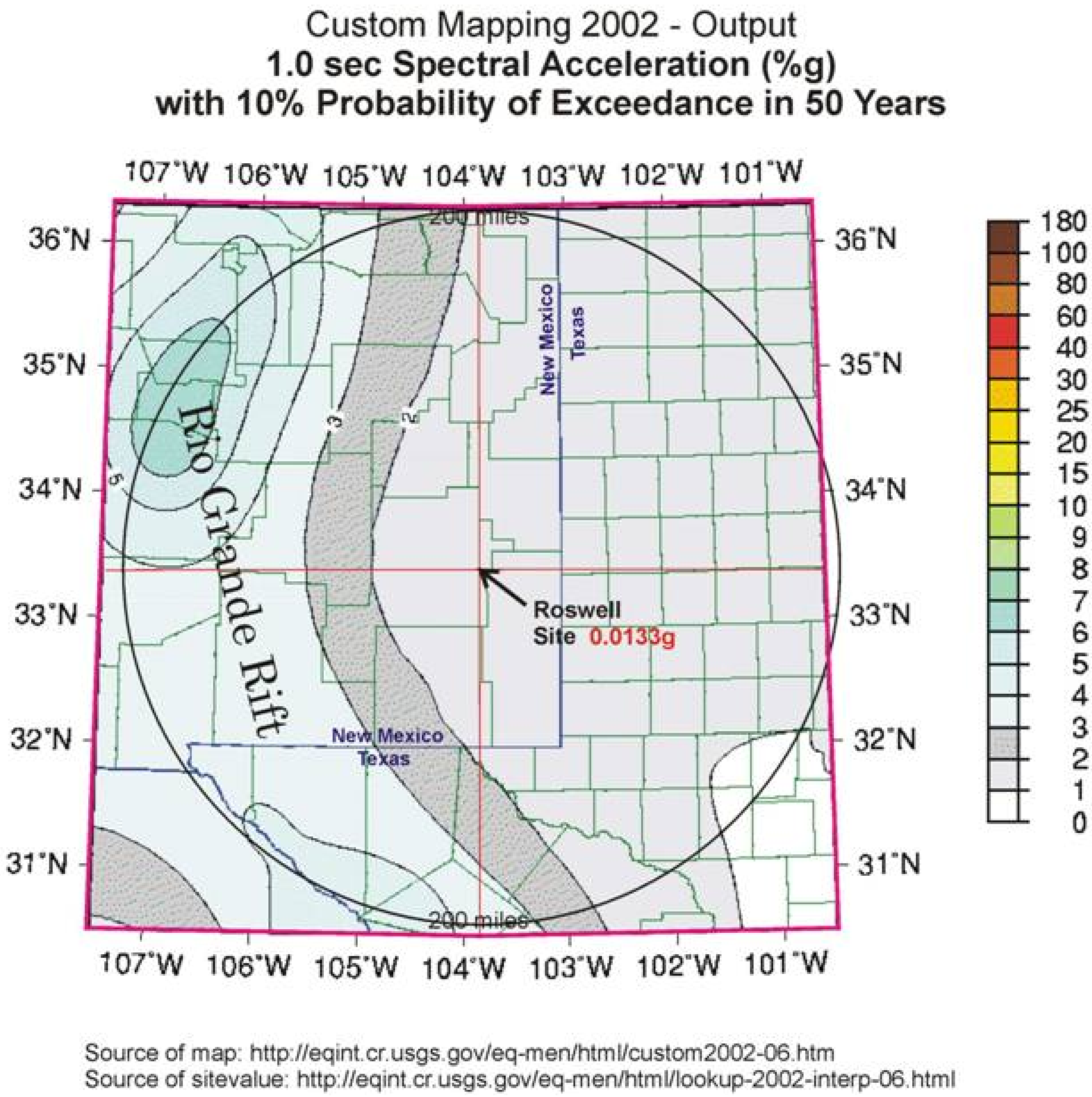
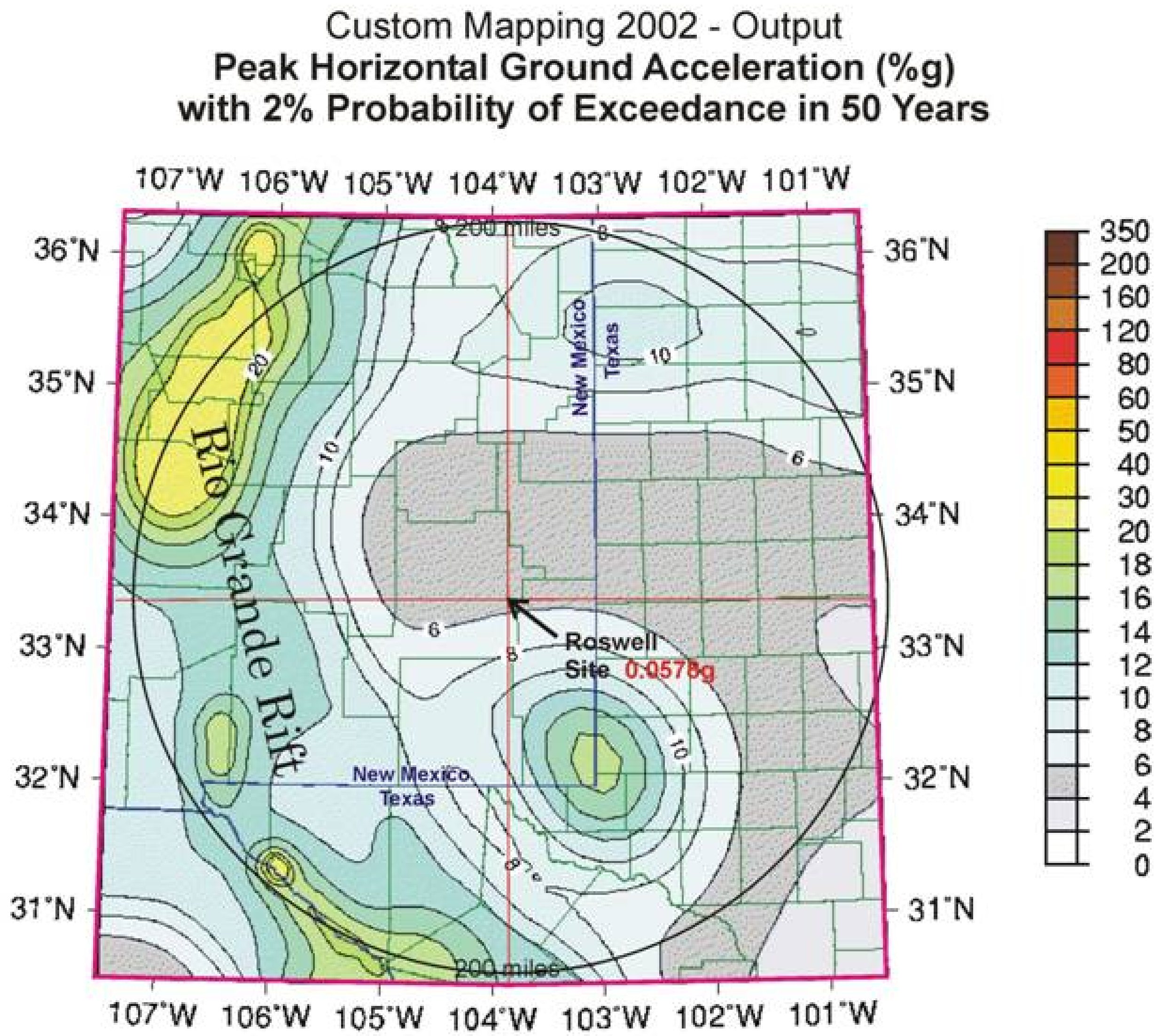


Figure 9-33. 1.0-second spectral horizontal acceleration (%g) with a 10 percent PE in 50 years (return period = 475 years). Spectral acceleration at the site is predicted to be 0.0133 g (9-026).



Source of map: http://eqint.cr.usgs.gov/eq-men/html/custom2002-06.htm
Source of sitevalue: http://eqint.cr.usgs.gov/eq-men/html/lookup-2002-interp-06.html

Figure 9-34. Peak horizontal acceleration (%g) with a 2 percent PE in 50 years (return period = 2,475 years). PGA at the site is predicted to be 0.0578 g (9-026).

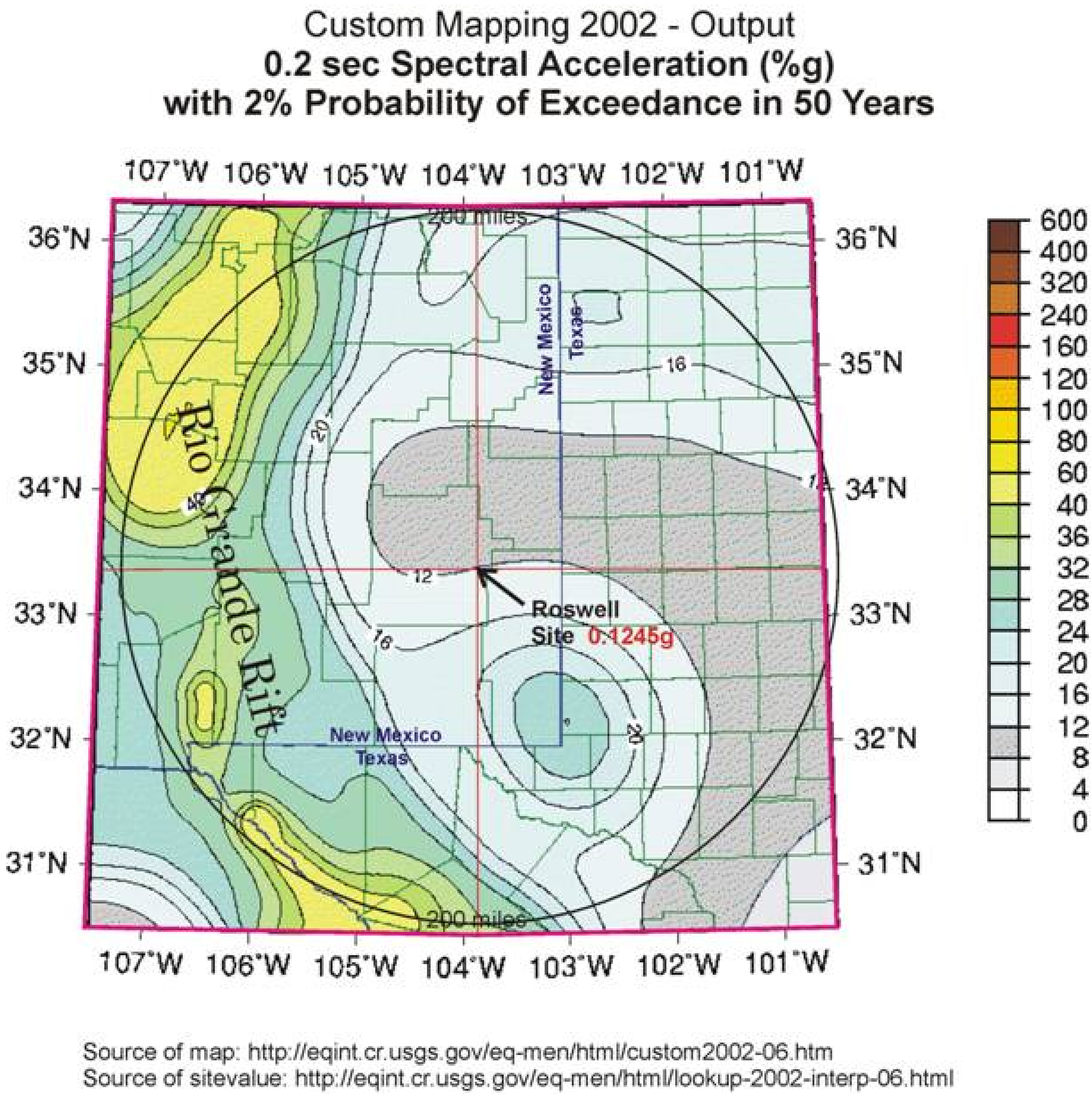


Figure 9-35. 0.2-second spectral horizontal acceleration (in percentg) with a 2 percent PE in 50 years (return period = 2,475 years). Spectral acceleration at the site is predicted to be 0.1245 g (9-026).

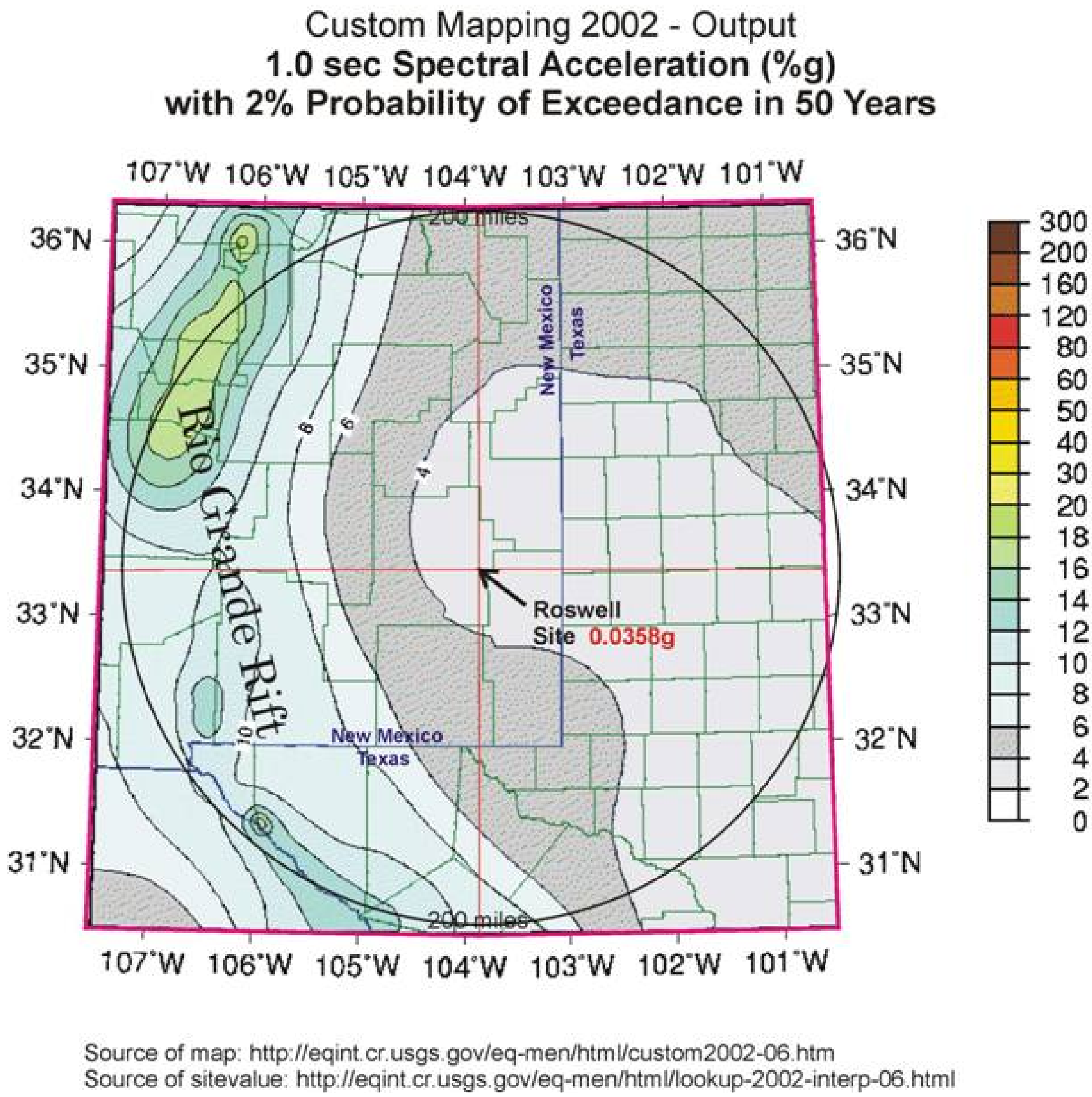


Figure 9-36. 1.0-second spectral horizontal acceleration (%g) with a 2 percent PE in 50 years (return period = 2,475 years). Spectral acceleration at the site is predicted to be 0.0358 g (9-026).

Table 9-15. Ground motion values for the Roswell site (9-026).

LOCATION: Latitude 33.3645, Longitude 103.8486.		
	10 percent PE in 50 years[a]	**2 percent PE in 50 years[a]**
PGA	2.08	5.78
0.2 sec SA	4.62	12.45
1.0 sec SA	1.33	3.58

a. The interpolated Probabilistic ground motion values, in percent g, at the requested point

PE = probability of exceedance
PGA = predicted ground acceleration
SA = spectral acceleration

9.3.2 Surface Faulting

The information about surface faulting required by 10 CFR100, Appendix A Section (b) is presented in Table 9-16. The particular topical area identified in this portion of the Code of Federal Regulations (CFR), the specific CFR section, and the information pertinent to that topical area are provided in this table. This information shows that surface faulting is unlikely due to the absence of mapped faults near the site.

Table 9-16. Summary of information related to surface faulting.

Topic	Requirement	Finding
Geologic Setting	10 CFR 100, Appendix A Section(b)(1) Determination of lithologic, stratigraphic, hydrologic, and structural geologic conditions of the site and the area surrounding the site, including its geologic history.	There are no mapped faults at the site or within 50 miles of the site, although the presence of a buried fault about 38 miles from the Roswell site has been inferred. Numerous faults are present in the Rio Grande Rift, which lies about 100 miles west of the site. The geologic setting of the site is described in more detail in Section 9.2.
Tectonic Structures	10 CFR 100, Appendix A Section (b)(2) Evaluation of tectonic structures underlying the site, whether buried or expressed at the surface, with regard to their potential for causing surface displacement at or near the site. The evaluation shall consider the possible effects caused by man's activities such as withdrawal of fluid from or addition of fluid to the subsurface, extraction of minerals, or the loading effects of dams or reservoirs.	There are no known tectonic structures underlying the site.
Evidence of Fault Offset	10 CFR 100, Appendix A Section (b)(3) Determination of geologic evidence of fault offset at or near the ground surface at or near the site.	There are no mapped faults within 5 miles of the site
Evaluation of Fault Capability	10 CFR 100, Appendix A Section (b)(4) For faults greater than 1,000 feet long, any part of which is within 5 miles of the site, determination of whether these faults are to be considered as capable faults.	There are no mapped faults within 5 miles of the site

Table 9-16. (continued).

Topic	Requirement	Finding
Listing of Historical Earthquakes	10 CFR 100, Appendix A Section (b)(5) Listing of all historically reported earthquakes which can reasonably be associated with capable faults greater than 1,000 feet long, any part of which is within 5 miles of the site, including the date of occurrence and the following measured or estimated data: magnitude or highest intensity, and a plot of the epicenter or region of highest intensity;	There are no capable faults within 5 miles of the site.
Correlation of Epicenters of Highest Intensity Historical Earthquakes with Tectonic Structures	10 CFR 100, Appendix A Section (b)(6) Correlation of epicenters or locations of highest intensity of historically reported earthquakes with capable faults greater than 1,000 feet long, any part of which is located within 5 miles of the site.	There are no capable faults within 5 miles of the site.
Characteristics of Capable Faults	10 CFR 100, Appendix A Section (b)(7) For capable faults greater than 1,000 feet long, any part of which is within 5 miles of the site, determination of: i. The length of the fault; ii. The relationship of the fault to regional tectonic structures; iii. The nature, amount, and geologic history of displacements along the fault, including particularly the estimated amount of the maximum Quaternary displacement related to any one earthquake along the fault; and iv. The outer limits of the fault established by mapping Quaternary fault traces for 10 miles along its trend in both directions from the point of its nearest approach to the site	There are no capable faults within 5 miles of the site.

9.4 Seismically Induced Floods and Water Waves

This section provides information about floods caused by seismic events required by 10 CFR 100, Appendix A IV(c).

The site is not subject to hazards from either tsunamis or seiches. There is no risk of tsunamis (a sea wave generated by submarine seismic or volcanic activity) at the site because it is approximately 4,000 feet above mean sea level and because it is located more than 500 miles from ocean coastlines (Figure 9-37).

Seiches (a periodic oscillation in the water surface elevation of a water body, whose period is controlled by the resonant characteristics of the water body) typically occur in large lakes, reservoirs, or other enclosed or restricted surface water bodies. There is no risk of seiches at the site because there are no large bodies of surface water near the site (Figure 9-38). The closest large water body, the Pecos River, is about 35 miles from the site.

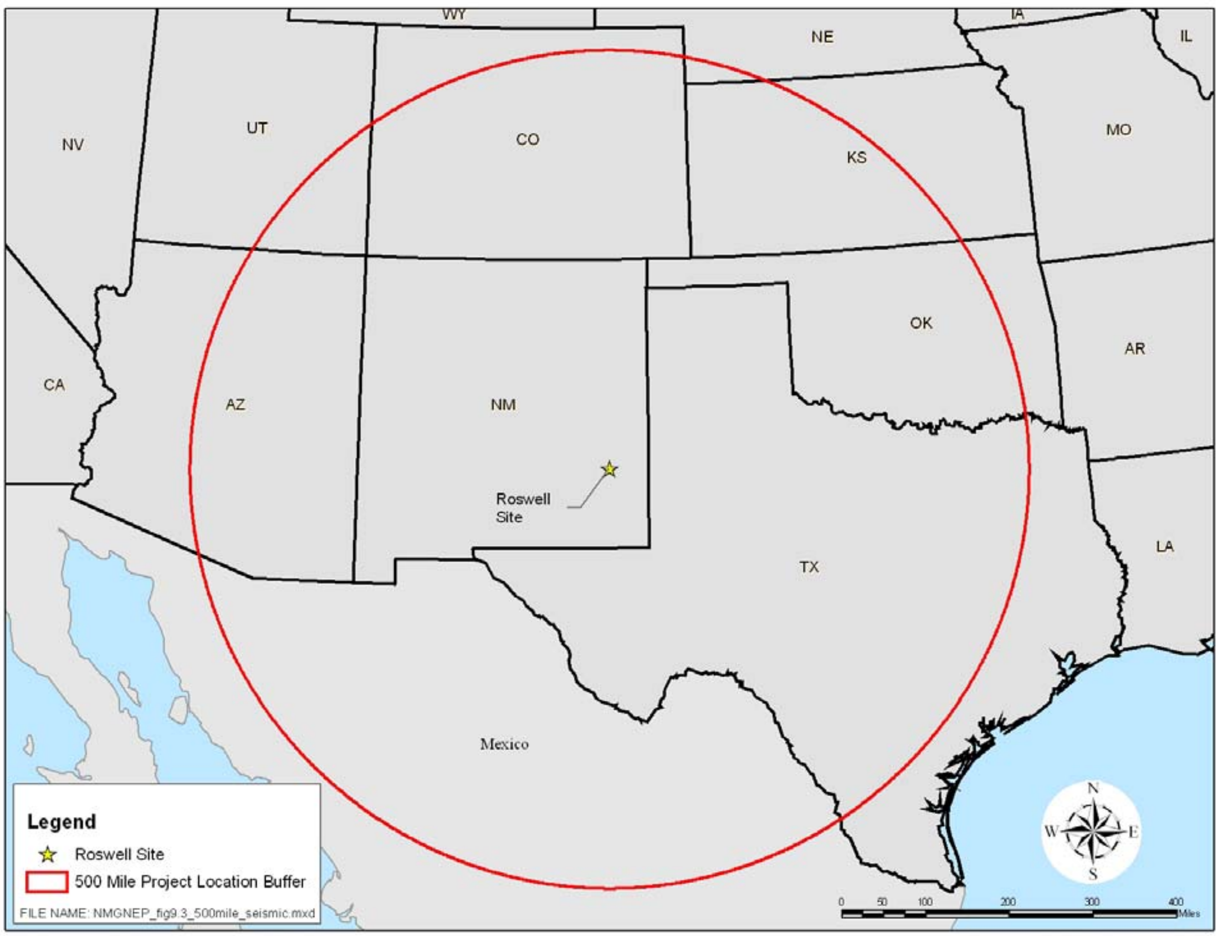


Figure 9-37. The site is more than 500 miles from an ocean coastline (9-052).

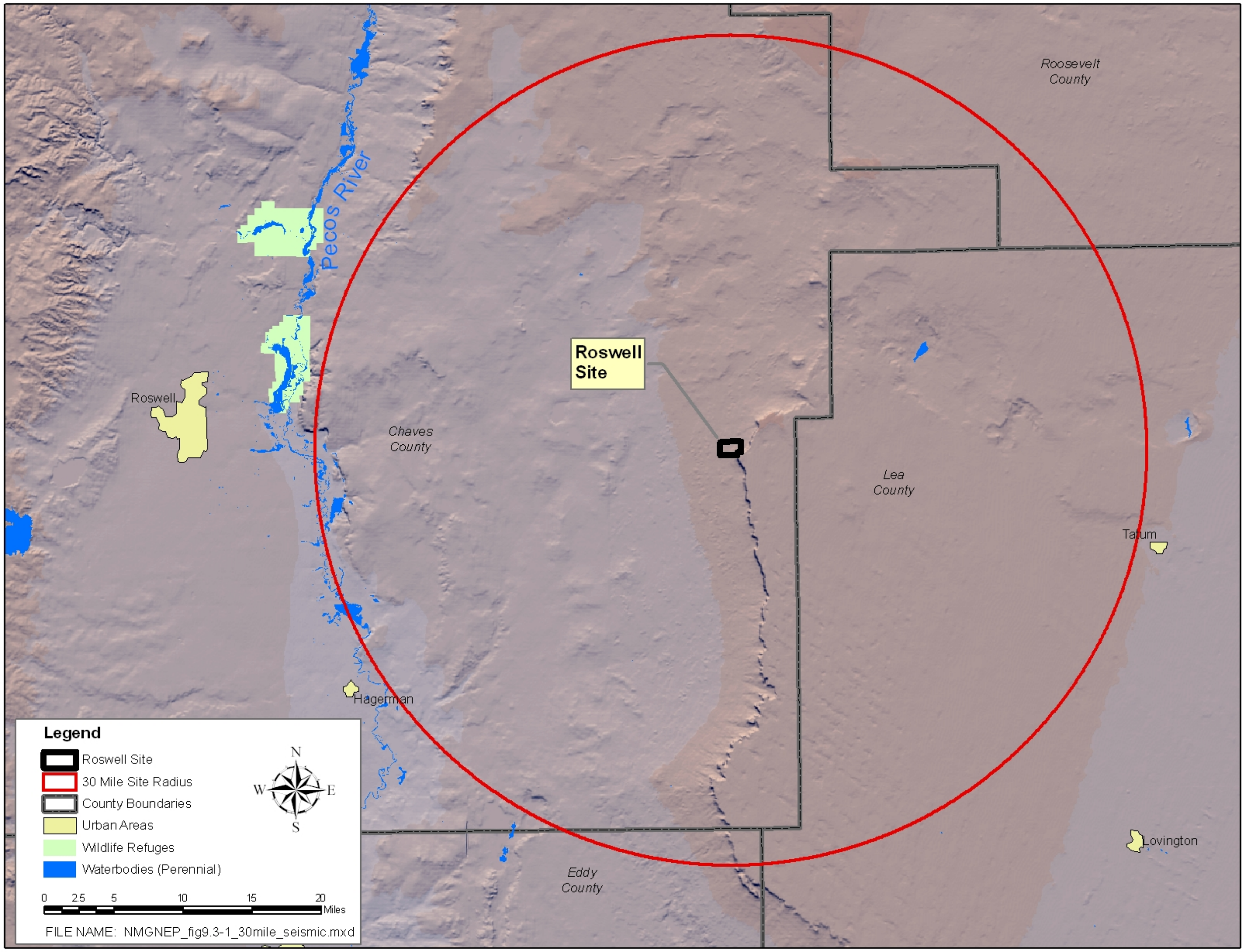


Figure 9-38. The closest significant surface water body, the Pecos River, is approximately 35 miles from the Roswell site (9-051, 9-054, 9-058).

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*Indicates those considered, but not cited.